HOME STRETCH
FIRST A350-1000 NOSES INTO FINAL ASSEMBLY PHASE
REPORT P7

X APPEAL
NASA seeks budget boost to support experimental flight tests of supersonic demonstrator by 2021 **9**

CRASH REVIEW
Six years on, why Polish government is restarting inquiries into Smolensk Tu-154 disaster **13**

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PROGRAMME

LIGHTNING THE MOOD

Italian F-35 aces transatlantic trek, but US DoD adjusts purchase plan

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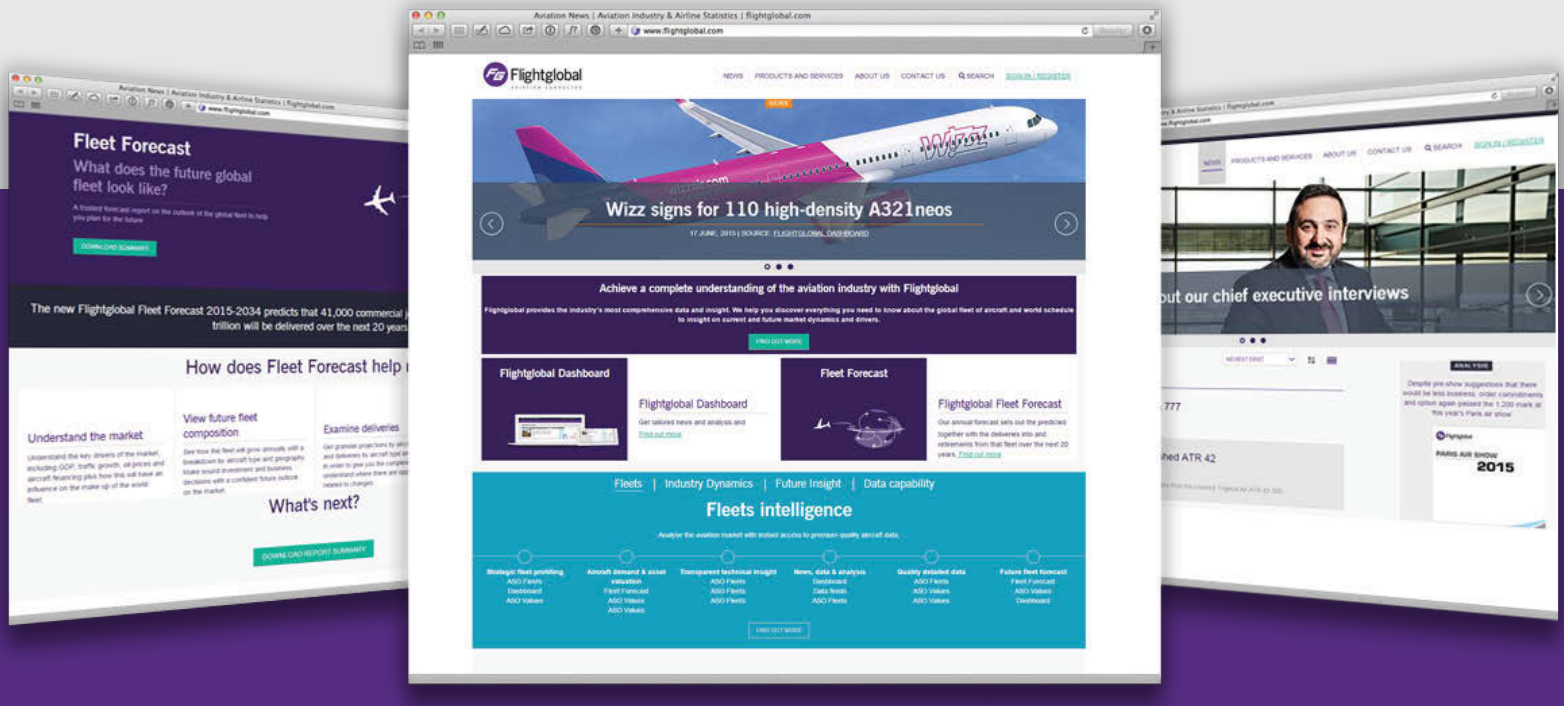

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Italian Air Force

COVER IMAGE

Italy's air force supplied this image of its first F-35A ready to refuel from a KC-767 tanker during the type's maiden crossing of the Atlantic Ocean P20

BEHIND THE HEADLINES

Beth Stevenson travelled to **Paris**, to attend the annual conference at France's **DGA** defence procurement agency (**P6**). **James Drew** welcomed **Italy's** first **F-35A** to NAS **Patuxent River** (**P20**), and **Stephen Trimble** was at a PNAA event in **Seattle** (**P11**)

BillyPix

NEXT WEEK SINGAPORE

Don't miss our all-angles coverage from the Singapore air show. And we detail the rotorcraft topics for Heli-Expo

NEWS

THIS WEEK

AIR TRANSPORT

OBITUARY

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UNMANNED SYSTEMS

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US Air Force

Lightning II output traded for operations support P16

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REGULARS

Boeing, Airbus Helicopters

Seattle confident narrowbody is well positioned P11. Airbus Helicopters changes tack on upgraded H225 P9

IMAGE OF THE WEEK

A formation of Lockheed Martin F-35As – three from the US Air Force and one Australian example – carry out a training sortie near Luke AFB in Arizona. The manufacturer says its programme surpassed the 50,000 flight hours mark in February. For more, see our F-35 training feature on P24

View more great aviation shots online and in our weekly tablet edition:

flightglobal.com/flight-international

Lockheed Martin

THE WEEK IN NUMBERS

158%

PwC

Aerospace and defence merger and acquisition deals hit a record $62bn in 2015 – more than double 2014's total

€237m

Flightglobal dashboard

Finnair made a 2015 operating profit, more than erasing 2014's €36.5m loss; revenue rose slightly, to €2.3bn

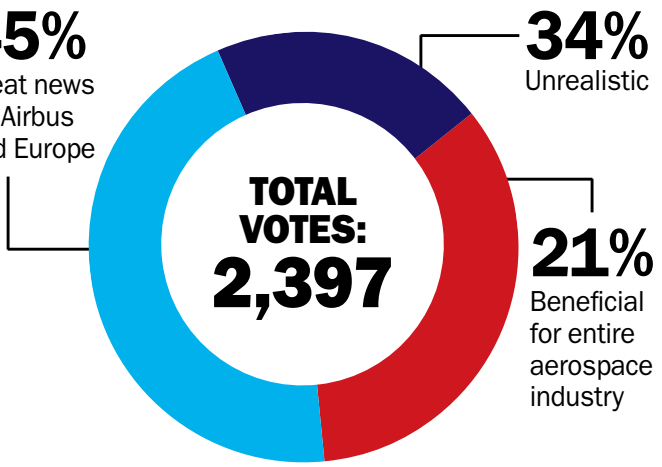
5,000

National League of Cities

Peak employment at Boeing's soon-to-close Long Beach C-17 plant, for which the city seeks a new "productive use"

QUESTION OF THE WEEK

Last week, we asked: **Is Iran's planned aviation expansion?**
You said:



This week, we ask: **F-35's transatlantic crossing?**
❑ Genuine achievement
❑ Brief lift for troubled programme ❑ Lindbergh managed it in 1927
Vote at flightglobal.com

Need for speed

Confirmation of NASA's proposal to fly a new generation of manned X-planes is an exciting development. But its pursuit of boom-free supersonic travel will not repeat 1950s drama

It was the golden age of flight experimentation when Scott Crossfield arrived at Edwards AFB, California, in 1950. The soon-to-be legendary test pilot likened the atmosphere to an "Indianapolis 500 without rules", as each flight attempted something – a speed, an altitude or some combination – that no human had ever before achieved.

In a 12-year span between the Bell X-1 and the North American X-15, the human speed record leaped from Mach 1.0 to Mach 6.7. Not surprisingly, commercial aviation roughly doubled in speed over the same time, as airline fleets transitioned from piston power to jet propulsion.

The goals of NASA's newly announced plan to revive the manned X-plane tradition may not seem quite so ambitious as the X-15, but it is also no mere nod to nostalgia. For the time being, there is no need to expand the boundaries of the human flight envelope of altitude and speed, which were set almost entirely over the Mojave desert during the 1950s. NASA is instead focusing on a narrower set of achievable goals that might transform the air travel experience in decades to come.

NASA's newly announced plan to revive the manned X-plane is no mere nod to nostalgia

The Anglo-French Concorde proved that a niche segment of the air transport market prizes speed over cost. Such a segment still exists, but supersonic speed may be unobtainable as long as sonic booms are outlawed over land.

Technology now available should be able to muffle the sound of the boom, but laws will not change until the scientific principle is proven using a flying demonstrator. NASA's low-boom sonic demonstrator – if approved by Congress – could unlock the supersonic market for business jets after a decade. Another generation of aerodynamic optimisation may yield the same speed benefit for commercial airliners.

US Air Force

The Mach of progress

NASA's proposal also includes a request to launch a subsonic X-plane. The candidates include a hybrid wing-body, a double-bubble fuselage and a strut-based wing. Nothing in these designs will make commercial air travel any faster, but they represent aviation's best hope for making the biggest leap in fuel efficiency since the advent of the high-bypass turbofan engine in the late 1960s.

Of the three concepts, NASA's scientists may prefer the hybrid wing-body, but the outlook for such a design in the commercial market is doubtful. As a commercial technology, the most promising candidate may be the strut-braced wing, but only if concerns about flutter and control can be overcome. ■

See This Week P9

Greased Lightning

The Lockheed Martin F-35 Lightning II has become a lightning rod for quick-hit budget savings in the Pentagon's latest military spending plan, despite what the programme office would have you believe.

Less than a week after celebrating a first transatlantic crossing by an Italian-assembled F-35A, refuelled by an Italian air force KC-767, bad news quickly befell the fifth-generation fighter. Its largest customer, the US Air Force, is to defer 45 orders across its five-year budget proposal, and won't hit 60 aircraft per year until 2021.

With a procurement cost of $391 billion for 2,457 US F-35s, it's no wonder that when the books are squeezed, number crunchers in the Pentagon turn to this largest account for savings.

As recently retired air force vice chief of staff Gen Larry Spencer asks, how long can the service back off buying the F-35 before those new weapons designed specifically to counter it are introduced? And is it at risk of becoming another Lockheed F-22 or Northrop Grumman B-2 – costly programmes so troublesome that the fiscal Grim Reaper struck before they could be fielded in operationally significant numbers?

F-35 czar Lt Gen Christopher Bogdan says no, and claims the changes will hardly be felt. Time will tell, but with aviation cuts and deferrals proposed that will impact every congressional district, US lawmakers might not be as kind to the F-35 in fiscal year 2017. ■

See Defence P16, News Focus P20

For more coverage of the burgeoning unmanned air vehicle sector log on to flightglobal.com/UAV

BRIEFING

NO EMERGENCY CALL FROM DAALLO A321 PILOT

INVESTIGATION Pilots of the Daallo Airlines Airbus A321 that suffered an in-flight explosion after departing Mogadishu initially cited a pressurisation issue, but did not declare an emergency. French investigation authority BEA has disclosed initial details of the 2 February incident, citing preliminary information from its Somali counterparts. Investigators believe the aircraft was climbing through a height of around 12,000ft at the time. One occupant of the aircraft is suspected to have been ejected through the rupture in the fuselage caused by the explosion. The Somali transport minister has reportedly attributed the damage to a bomb.

US NAVY OSPREY GIVEN NEW DESIGNATION

NAMING The US Navy has designated its future long-range variant of the Bell Boeing V-22 Osprey the CMV-22B. The tiltrotor has been chosen to replace the Grumman C-2 Greyhound in the USN's carrier onboard delivery role, with 44 examples to be delivered from 2020. The navy wants to increase the Osprey variant's unrefuelled range to 1,150nm (2,130km), from a current 860nm.

737 CLEARED TO DEPART FROM CLOSED RUNWAY

INCIDENT Spanish investigation authority CIAIAC is looking into an incident involving a Germania Boeing 737-700 that was cleared to depart from a closed runway at Las Palmas airport on 7 January. The aircraft (D-ABLB) had been authorised for take-off from runway 03R, although it had been shut for work to be carried out. After starting their take-off run, air traffic control ordered the crew to abort, and the 737 was brought to a halt. None of the 135 passengers and five crew members on board the aircraft were injured, CIAIAC says.

SUKHOI HUNGARY FOR FLAG CARRIER ROLE

AIRLINES Hungary's government has received an approach from a Russian aircraft manufacturer regarding the creation of new national carrier for the country. The nation has been without a formal flag carrier since the collapse of Malev in early 2012, shortly after the European Commission ordered it to repay large sums of state aid. Hungary's national development ministry says preliminary talks over a successor were "initiated" by a Russian airframer – which *Flight International* understands to be Sukhoi – in late autumn last year.

MRJ RESUMES TEST FLIGHTS FOLLOWING UPGRADES

PROGRAMME Mitsubishi Aircraft has resumed flight tests of its initial MRJ prototype following a two-month lay-up for structural modifications. Mitsubishi says it was able to "confirm the upgrades" that have been made to the prototype during a 90min flight over the Pacific coast of Japan on 10 February. It was the fourth flight of the aircraft. The regional jet required structural reinforcements and system software upgrades following its previous sortie on 27 November 2015. The manufacturer plans to redesign a number of parts on production versions of the twinjet to strengthen the wing root and fuselage above the centre wing.

US MILITARY TO REPLENISH AIR-LAUNCHED ARSENAL

MUNITIONS The US Department of Defense is seeking to replenish a depleted stock of precision-guided weapons via its budget request for fiscal year 2017. In total, the Pentagon hopes to procure more than 45,000 air-launched weapons – an almost one-third increase from its enacted total of almost 34,000 ordered in FY2016.

See Defence P16

Thirty examples of the Sagem type are now expected to be procured

Olivier Lapy/Sagem

COMPETITION BETH STEVENSON PARIS

Patroller selection was fair, says DGA

French defence procurement agency insists army's choice of domestic UAV over Watchkeeper followed due process

The head of France's DGA defence procurement agency has defended the selection of Sagem's Patroller for the French army's tactical unmanned air vehicle requirement, insisting that the competition was fair and did not dismiss the rival Thales Watchkeeper from the outset.

Formally acknowledging the planned acquisition of the Patroller on 10 February, following several weeks of speculation, Laurent Collet-Billon, head of the DGA, told media in Paris that the contest was "certainly not against the Watchkeeper" – a type originally developed for the British Army.

Derived from Elbit Systems' Hermes 450, the Watchkeeper had long been pitched to France.

"It's a long story," Collet-Billon says. "The Watchkeeper [previously] experienced a different assessment by the army, but on both sides of the Channel it was concluded that there had to be a competition. We opened it to offers. This is the choice of the army. [It] decided it, and there will be no modification to that."

The tactical UAV programme aims to replace the Sagem Sperwer UAV. Thirty air vehicles are expected to be procured, but an order has not yet been placed. ■

See News Focus next week

REQUIREMENT JAMES DREW WASHINGTON DC

Lockheed drops clean-sheet T-X bid

Lockheed Martin will offer an upgraded version of the T-50 fighter it jointly developed with Korea Aerospace Industries (KAI) for the US Air Force's 350-aircraft T-X trainer programme, forgoing a clean-sheet alternative designed by its Skunk Works division.

The company on 11 February confirmed that it will build the upgraded T-50A in Greenville, South Carolina, using major components including the wings, fuselage and tail assembled in South Korea. It is already standing up a "warm" final assembly and checkout facility that should be ready by year-end.

KAI unveiled the T-50A last December, and the first two production examples are due to arrive in the USA "later this year" for testing and demonstration.

"Our clean-sheet team thought we had a great airplane, but it doesn't do much more than the T-50," says Lockheed executive Rob Weiss. Skunk Works had completed 80% of detailed design work, but the model would have cost eight times more to fully develop, he adds. ■

Engine will Leap into action, says CFM

THIS WEEK P8

DEVELOPMENT **STEPHEN TRIMBLE** SEATTLE

Boeing starts countdown to launch?

Airframer may be edging closer to starting development of middle-market programme, with decision potentially by year-end

Despite spending months pleading for patience, Boeing executives are now telling employees a launch decision for a new airliner aimed at the "middle of the market" (MOM) could be made by the end of the year.

In an all-hands meeting with employees on 10 February in Seattle, Boeing Commercial Airplanes chief executive Ray Conner said the project may launch as early as 2016, sources say.

Since at least 2012, Boeing has identified a gap in the market between the single-aisle 737 Max 9 and the widebody 787-8. Two years of discussions with customers revealed a consensus for an aircraft with about 20% more range and payload than a 757-200.

There has been little urgency to this decision – until now. Only a day before Conner's address to employees, Boeing vice-president of marketing Randy Tinseth said his team "have a lot of time" before making a choice.

But the 737 Max 9 has struggled to compete against the Airbus A321neo. Sales of the 787-8 have also slowed since the introduction of the stretched -9 variant. In addition, Boeing has a six-year backlog of major commercial projects already in development, starting with the entry into service of the 737 Max 8 next year. The 787-10 is scheduled for delivery in 2018, followed by the 777-9 in 2020 and then the 777-8.

A MOM aircraft is not likely to appear before 2022, giving Boeing at least six years to complete development if a programme is launched later this year.

Potential customers such as Air Lease founder Steven Udvar-Hazy have pressured Boeing to deliver a clean-sheet aircraft that combines the range and payload of a small widebody, such as the 767-200, with the operating economics of a narrowbody like the 737-800.

Two industry analysts have concluded such an aircraft would require a new fuselage shape – elliptical instead of circular – to reduce aerodynamic drag while still providing enough payload.

Such an aircraft also may require new engines sized in a thrust-class between existing narrowbody and widebody engines, leading GE Aviation chief executive David Joyce to speculate last year that a clean-sheet engine design would be required.

Other concepts are reportedly under consideration, including a larger version of the 737 Max. ■

See Air Transport P11

US Air Force

Next-generation bomber is destined to replace Boeing B-1B fleet

BUDGET **JAMES DREW** WASHINGTON DC

USAF trims spending on LRS-B

The US Air Force's funding profile for development of the Northrop Grumman long-range strike bomber (LRS-B) has come down by $2.8 billion in the service's latest budget proposal, submitted on 9 February.

Service officials say that while the sum being requested is much less than that sought from Congress between 2017 and 2020 in last year's spending profile, its classified "programme content" remains the same.

The $80 billion programme to build 100 next-generation bombers was awarded to Northrop last October. Each aircraft will cost $564 million, according to US government estimates.

"All that's happened is we've had a new cost estimate because we've had a competition," explains USAF budget deputy Carolyn Gleason. "We've downselected, we have a winner, and we know that winner's business strategy and technology strategy, so that's purely an update to a cost estimate. The programme content is the same."

The losing LRS-B bidding team – comprised of Boeing and Lockheed Martin – late last year protested Northrop's selection. A decision by the US Government Accountability Office on whether to uphold or deny their appeal is due by mid-February. ■

See Defence P16

PROGRAMME

First A350-1000 begins taking shape in Toulouse

Airbus has commenced final assembly of the A350-1000, the stretched version of the airframer's long-haul twinjet.

The -1000 under construction at Toulouse is one of three which will be built for flight tests due to begin this year.

It has been transferred to the Station 50 point for fuselage join and fitting of the nose-gear, before being sent to Station 40 for wing mating and installation of main landing-gear and other structures.

The airframer says it will carry out initial cabin fitting and electrical power-on in parallel to the structural assembly.

Airbus has secured orders for 181 of the 366-seat type, which will be powered by Rolls-Royce Trent XWB-97 engines, and aims to begin delivering the jets in mid-2017.

Flight-testing of the Trent XWB-97, a higher-thrust version of the engine used on the A350-900, began last year. ■

Airbus

Prototype is one of three flight-test articles for stretched variant

PROPULSION **STEPHEN TRIMBLE** WASHINGTON DC

Engine will Leap into action, says CFM

Joint-venture manufacturer distances its new narrowbody powerplant from issues befalling rival PW1100G geared turbofan

Start-up times are not a problem for the Leap-1A engine nearing entry into service on the Airbus A320neo, says powerplant joint venture CFM International.

The Leap-1A engines, which are due to make their operational debut on the A320neo in mid-2016, need 50s to spool-up after the activation sequence is started, says CFM executive vice-president Allen Paxson.

That is within "a handful of seconds" of the time required by the CFM56 engine that the Leap-1A replaces on the A320 family, he adds. This start-up time appears to contrast with the same requirement for the first batch of Pratt & Whitney PW1100G engines, CFM's rival on the A320neo.

In December, Airbus delayed entry into service of the A320neo by one month after original launch customer Qatar Airways objected to the start-up time requirement for the PW1100G engine. Instead, Lufthansa accepted the first Neo and launched services in late January.

Meanwhile, P&W parent United Technologies has said the excess start-up timing requirement on early engines is needed to prevent components in the engine from overheating.

A hardware and software upgrade is expected to be ready this month for PW1100Gs now in final assembly. Those engines will likely begin entering service on delivered A320neos beginning early in the second quarter.

CFM officials are keen to distance the upcoming Leap-1A from such concerns. Their engine is scheduled to enter service on the A320neo in mid-2016.

The Leap-1A engine was designed to minimise the start-up time requirement, says CFM executive vice-president Francois Bastin. Key electronics are located near the front of the engine close to the fan, which means they are installed in a "cooler environment", he says. "That's taken into account in the very early stages of the design," he adds.

CFM remains on track to deliver the first production version of the Leap-1A soon to Airbus for installation on a customer A320neo. Test cell data has confirmed the engine meets Airbus's and customer specifications, Bastin says. ■

CFM International

Leap engines will power three aircraft types, including the Neo

SALES

'Life is good' as orders pass 10,000 mark

CFM International signed new orders for 2,154 engines in 2015 to power five commercial aircraft types in production or early development, says the GE Aviation-Snecma joint venture.

The numbers reflected the slower sales logged in 2015 by Airbus and Boeing compared with the industry records set the previous year. In 2014, CFM reported 4,244 new orders, including 2,717 for the Leap engine family and 1,527 for the CFM56 engine.

But the delivery pace continued growing in 2015, with 1,638 CFM56 engines produced – 5% more than in 2014. That number is expected to rise above 1,700 engines in 2016, despite Boeing recently forecasting fewer 737 deliveries this year.

"For CFM, life is good," says Jean-Paul Ebanga, CFM president and chief executive.

In January, the Leap engine family crossed the 10,000-order mark, despite not being scheduled to enter service until mid-2016 on the Airbus A320neo. Additional variants will be produced for the 737 Max and Comac C919. ■

PROGRAMME **DAVID KAMINSKI-MORROW** LONDON

Neo family grows as largest variant gets airborne

Airbus has started test flights with the A321neo, the largest member of its re-engined single-aisle family.

The aircraft (D-AVXB), fitted with CFM International Leap-1A engines, took off on its maiden sortie from Airbus's Finkenwerder plant in Hamburg on 9 February.

Airbus says the aircraft, with five crew members on board, was airborne for 5h 29min.

The airframer adds that tests comprised engine-speed variations, systems behaviour and flight-envelope validation.

Airbus says the A321neo will undertake a "partial" flight-test programme to examine specific aspects associated with the larger type's performance.

It also plans to start test flights with the Pratt & Whitney PW1100G-powered version in a few weeks.

The P&W powerplant has been undergoing adjustments to deal with start-up issues relating to thermal differentials.

"It doesn't really make a difference which engine type makes the first flight as we are working to commit to our delivery targets for our customers," says Airbus.

Airbus has secured orders for 1,094 of the type, with over 400 destined for major customers comprising Air Lease, Wizz Air, American Airlines and Turkish Airlines.

Initial deliveries of the A321neo are scheduled to take place towards the end of this year.

Figures from Flightglobal's Fleets Analyzer database give P&W a 36% share of the A321neo market, with CFM on 21%. However, no engine selection has been made on the remaining 43% of orders. ■

Airbus

9 February flight of re-engined narrowbody lasted for 5h 29min

Boeing bids to revive 747-8 build rate
NEWS FOCUS P10

POLICY STEPHEN TRIMBLE WASHINGTON DC

NASA budget sets stage for return to the X-plane factor

Agency's FY2017 proposal set to provide 23% increase in funding for groundbreaking aeronautics research division

X-15 became the first manned hypersonic aircraft, in 1959

NASA

NASA plans a return to a decades-old tradition of developing and flying experimental aircraft projects, or "X-planes", in order to achieve new breakthroughs in super- and subsonic aeronautics research.

The fiscal year 2017 budget proposal submitted to Congress on 9 February reveals a 23% leap in funding for NASA's aeronautics research division, rising from $640 million in FY2016 to $790 million next year. The agency also released a 10-year outlook with aeronautics funding peaking at $1.3 billion in FY2023, when two possible X-planes are scheduled to be flying.

"It felt like Christmas in January," says Jaiwon Shin, NASA's associate administrator for aeronautics research, recalling the moment when the agency's final request was confirmed.

The funding levels still track well below the $2 billion annual sums once allocated to NASA's aeronautics branch through the 1980s, but are still roughly double the average spending enacted over the last decade.

X-planes are usually associated with US military projects, but NASA and its predecessor agency has a long history of achieving in-flight aeronautic breakthroughs, with such projects as the supersonic Bell X-1 and the hypersonic North American X-15.

Recently, NASA has worked mainly in the laboratory and the windtunnel, while maintaining a small fleet of research aircraft, including the miniature-scale Boeing X-48 hybrid wing-body.

But Shin has been pushing for a decade to revive the agency's X-plane tradition. He played a key role in developing the first presidential policy for aeronautics research and development, which encouraged the use of X-planes to validate laboratory and windtunnel findings in the air.

INVESTMENT

As early as 2012, NASA appeared poised to launch a hybrid wing-body X-plane programme, capping a five-year investment in laboratory work and subscale flight research under the environmentally responsible aviation project.

NASA's high-speed research office has recently completed a series of studies showing that technology available today should be able to muffle the sonic boom produced by a supersonic aircraft, potentially allowing civil aircraft to fly overland above Mach 1.0.

NASA will develop a preliminary design for a supersonic X-plane in FY2016, then launch a competition next year to develop and build the low-boom supersonic demonstrator. Flight tests could begin as early as 2021.

NASA will also launch in FY2017 a preliminary design for a hybrid wing-body, subsonic demonstrator. But that will compete with two other concepts – a horizontally-aligned double-bubble airframe and a truss-braced wing – to be developed as NASA's next subsonic X-plane.

The budget includes funding for other demonstrators, including sub-scale aircraft with hybrid-electric propulsion systems. ■

ROTORCRAFT DOMINIC PERRY LONDON

Change of course on H225 means 2B is not to be

Airbus Helicopters plans to deliver the first upgraded H225 heavy twin to launch customer Lease Corp International in early 2017, but has dropped an uprated engine from the package of enhancements and scaled back a planned weight increase.

Launched in February 2014 as the EC225e, the helicopter was due for certification in late 2015 and was intended to use a new variant of the Turbomeca Makila powerplant, the 2B. This promised a payload boost of 550kg (1,210lb), bringing the H225's maximum take-off weight (MTOW) closer to that of the rival Sikorsky S-92. Radius-of-action would grow by 50nm (92km) with 19 passengers, or 300nm with 10 passengers and an additional fuel tank.

However, faced with an oil and gas market in crisis, Airbus Helicopters late last year took the decision to ditch the new engine on cost grounds, and rely on the current Makila 2A1. The airframer believes sufficient performance gains can be achieved using other elements of the enhancement package.

Airbus Helicopters

Maximum take-off weight will rise to 11,160kg on the heavy twin

Turbomeca says it has now frozen development of the 2B variant, despite flight tests having begun in 2014. It featured a new combustion chamber and high-pressure turbine blades for increased take-off performance and payload capability.

The decision means MTOW on the H225 will now increase to 11,160kg – a rise of just 160kg over the previous figure – still allowing the optional installation of an extra fuel tank.

That maintains the proposed radius-of-action increase with 10 passengers, although with 19 passengers Airbus Helicopters simply says it allows around 20min of additional flight time.

The airframer is still proceeding with an avionics upgrade for the type, however. A key element of that – an option for oil and gas operators – is its new Rig 'N' Fly system, which allows automated approaches to offshore platforms.

This has gained certification from the European Aviation Safety Agency and will also be available on the H175 from end-2016, and the developmental H160. ■

FORECAST **STEPHEN TRIMBLE** WASHINGTON DC

Boeing plans 747-8 build-rate revival

Airframer predicts return to output of 12 per year by 2019, on back of improved demand driven by freighter fleet renewal

Boeing has revealed long-term plans to double the planned production rate on the 747-8 programme in 2019, despite near-term output reductions on the back of low orders and a diminished backlog.

The build rate on the 747-8 line is falling from 1.3 per month today to 0.5 per month in September 2016, reflecting continued anaemic growth in the air cargo market.

But Boeing's newly-released annual report says the company anticipates that rate will return to 12 per year from 2019.

"We are currently producing at a rate of 1.3 per month with plans to reduce the rate to one per month in March 2016, further reduce the rate to 0.5 per month in September 2016 and then return to one per month in 2019," the company says.

AirTeamImages

A sluggish cargo market is one reason for the jumbo's malaise

The 747-8 assembly line has struggled to stay alive and many analysts have suggested Boeing is likely to end production in the near future.

But Boeing executives have made slightly more optimistic statements, acknowledging a slow current market but predicting that demand could pick back up in 2019 as around 200 older 747 freighters reach retirement age. That refleeting requirement could spur renewed interest in the jumbo, it believes. However, Boeing also warns in its annual report that another forward loss could be reported on the 747-8 if new sales do not materialise.

Boeing also warns in its annual report that another forward loss could be reported... if new sales do not materialise

"We have a number of completed aircraft in inventory as well as unsold production positions and we remain focused on obtaining additional orders and implementing cost-reduction efforts," Boeing adds.

Boeing's most recent order and delivery data records a total of 19 747s in its backlog, split between seven freighters and 12 of the passenger model. However, six orders for the latter – for Arik Air and defunct Russian carrier Transaero – are unlikely to be fulfilled. ■

PRODUCTION

Conner warns of job cuts as costs drag on competitiveness

Boeing Commercial Airplanes chief executive Ray Conner on 10 February announced plans to reduce jobs to counter rising competitive pressures.

The announcement in a company-wide webcast did not reveal the extent or timeline for any reductions of the 82,545-strong workforce, and the exact number depends on "how effectively we bring down costs as a whole", Boeing says.

Lay-offs will start at the executive and managerial-level, Boeing says.

"We will also use attrition and voluntary lay-offs," the company adds. "As a last resort, involuntary lay-offs may be necessary."

The staff reductions are coming despite continued growth in the overall commercial market. Although Boeing plans to reduce output of the 747 and 777, production rates on the 737, 767 and 787 are growing rapidly over the next four years.

But trimming headcount is necessary to maintain a "healthy business" and "to win in the market", Conner says.

Boeing's 787 line is increasing output, but still has not become profitable on a unit- or programme-level basis. Indeed, Boeing has delivered roughly 370 787s so far at a combined loss of nearly $30 billion, not counting its undisclosed cost to develop the widebody twinjet.

To avoid reporting a forward loss, Boeing must repay a proportion of that bill on each of the next 930 787s off the assembly line.

That results in a need to build the remaining 787s at an average cost of $91 million each, says Teal Group vice-president of analysis Richard Aboulafia. ■

DEVELOPMENT **STEPHEN TRIMBLE** SEATTLE

CS300 to make operational debut in third quarter

Bombardier now says the CS300 variant of the CSeries aircraft family is on track to enter service in the third quarter with launch customer Air Baltic, clarifying previous statements that the milestone would occur in the "second half" of 2016.

Meanwhile, Swiss International Air Lines expects to launch services with the smaller CS100 variant in the second quarter.

The CS300 has logged over 400h of tests on more than 130 flights, according to Ross Mitchell, Bombardier's vice-president of business acquisition for commercial aircraft.

Certification of the 135-seat variant is expected to be in the second quarter, or within six months of the same milestone for the CS100, said Mitchell, speaking at the Pacific Northwest Aerospace Alliance conference in Seattle on 10 February.

The first production example of the CS300 is now undergoing final assembly at Bombardier's plant in Mirabel, Canada, says Mitchell.

The CS300 accounts for more than two-thirds of Bombardier's total backlog of 243 firm orders for the CSeries. ■

Bombardier

Type has logged 400h of tests

Lessor CIT 'hurt' by size of orderbook
AIR TRANSPORT P12

OUTLOOK STEPHEN TRIMBLE SEATTLE

Boeing upbeat on slow-selling Max 9

Seattle confident re-engined narrowbody is well-positioned, despite orderbook well behind that of rival Airbus A321neo

Though so far outsold by more than five to one by the Airbus A321neo, Boeing remains confident that the 737 Max 9 – the largest member of its re-engined narrowbody family – has the potential to grab market share.

At the Pacific Northwest Aerospace Alliance (PNAA) conference in Seattle on 9 February, Boeing vice-president of marketing Randy Tinseth defended the Max 9 on the same day that the A321neo completed its first flight.

"The Max 9 isn't as large but has a lower trip-cost as well as a lower seat-cost and so that's a nice combination, and it flies a bit further, so we think we're well-positioned," Tinseth says.

But airlines have ordered only 224 737 Max 9s compared with 1,094 A321neos, according to data from Flightglobal's Fleets Analyzer database and Airbus's most recent order figures.

Tinseth also argues that the smaller 150-180-seat-segment will claim about 60% of the sales in the single-aisle market, where Boeing offers the 737 Max 8 with up to 189 seats and the higher-density 737 Max 200.

He estimates that together the 737 Max 9 and A321neo will account for about 20-25% of overall demand for single-aisle aircraft over the next 20 years. But the combined backlogs for the two so far suggest even that could be optimistic: the 1,318 total orders represent around 17% of overall narrowbody commitments.

Boeing has hinted that it could launch a new aircraft – either a derivative or clean-sheet design – by year-end to plug the gap between the Max 9 and the 787-8, where Airbus today offers the A321neo and the re-engined A330-800.

Largest member of the Max family can accommodate up to 220 passengers

Boeing

A year ago, Tinseth had said that a months-long dialogue with customers had found a consensus of demand for a new aircraft in the "middle of the market" with more range and size than a 757.

But Tinseth now says the dialogue with customers has moved on to a new stage: "I think we're in that process now where we play catch-ball with our customers, and we start looking at options, what you can do, and you see how you can do it." ■

PROPULSION
STEPHEN TRIMBLE WASHINGTON DC

GE9X engine for 777X is 'coming together nicely'

GE Aviation has confirmed that final assembly has started on the first full-scale GE9X engine.

"The first full GE9X engine is coming together nicely," says Bill Millhaem, general manager of the GE90 and GE9X programmes.

GE froze the design for the 100,000lb-thrust (444kN)-class powerplant for the Boeing 777X six months ago. The full-scale first engine to test is scheduled to be ready later this year, and a second full-scale engine will follow in 2017 to be installed on a GE-owned Boeing 747 flying testbed.

Boeing plans to start flying the engine on the first 777-9 test aircraft in 2018, followed by certification the following year and entry into service in 2020.

The GE9X improves high-pressure compressor technology to achieve a fuel burn advantage over the GE90, with a compressor pressure ratio of 27:1. ■

SAFETY DAVID KAMINSKI-MORROW LONDON

EASA has key to solve cowl-loss issue

Operators of Airbus A320s are to be instructed to modify CFM International CFM56-powered aircraft in a bid to stem incidents involving loss of unlatched fan-cowl doors.

The measure is being put forward to help resolve a long-standing problem in which the doors are inadvertently left unsecured, typically after routine maintenance, and crews do not notice during pre-flight checks.

Left unlatched, the cowls can be torn off as the aircraft accelerates for departure, potentially damaging engine and airframe.

The modification comprises a new latch mechanism which requires a specific key to unlock the cowl door.

This key cannot be removed from the lock unless the latch is properly closed.

Once the door is closed the key, upon removal, must be stowed in the cockpit of the aircraft at a particular location, says a proposed European Aviation Safety Agency directive.

The flight crew operating manual and aircraft maintenance manual will be updated with the revised instructions.

EASA is proposing a 35-month period in which to carry out the modification. It only applies, so far, to the CFM56-equipped version of the A320 family and EASA has not indicated whether a similar directive will be drawn up for International Aero Engines V2500-powered aircraft.

Although there have been previous efforts to find a solution, an inquiry into the May 2013 cowl-loss on a British Airways A319 found that, although the rate of such incidents had been reduced, the increasing number of A320s in service had resulted in a greater number of occurrences. ■

Heathcliff O'Malley/REX/Shutterstock

BA A319 was damaged in 2013 after fan-cowl door left unlatched

FINANCE **ALEX DERBER** LONDON

Lessor CIT 'hurt' by size of orderbook

Requirement to set aside capital proportional to size of incoming fleet is "restricting growth", says boss of parent company

Any sale of CIT Aerospace would be as an integrated leasing unit rather than "simply a collection of aircraft", CIT Group chief John Thain has stressed.

The US financial services group is still pursuing either a sale or a spin-off of its aircraft leasing business as it moves towards a more conventional commercial banking model.

At the end of 2015, CIT Aerospace's assets were roughly $11 billion, making the lessor the largest division of its parent by assets under management.

However, its extensive on-order fleet ties up significant amounts of capital, which is "beginning to, basically, hurt the business because we [are] restricting its growth", said Thain during a results call on 2 February.

Boeing

Commitments include deal for 30 Boeing 737 Max narrowbodies

CIT has a total of 126 Airbus and Boeing aircraft on order, Flightglobal's Fleets Analyzer database indicates. The backlog has grown substantially in relation to CIT's roster of income-generating assets.

Aircraft on order will take many years to all be delivered and, until they are, regulations require that CIT set aside capital proportional to its commitments.

As a result, says Thain, CIT, like other lessors, is trading beneath its book value. While that would appear to discourage a sale, Thain believes that the leasing business has inherent value above that of its nominal assets, although a spin-off remains CIT's fall-back scenario.

Yet both divestment options require two hurdles to be overcome: the combination of CIT Aerospace's aircraft under a single legal entity and the creation of its own balance sheet.

CIT's Transportation & International Finance division, to which CIT Aerospace belongs, made pre-tax income of $156 million in the final quarter of 2015, compared with $141 million for the group as a whole. ■

DEVELOPMENT
TOM ZAITSEV MOSCOW

An-178 puts new engines through paces

Antonov has started flight testing its developmental An-178 transport with modified Ivchenko-Progress D-436 engines.

The high-wing aircraft – a derivative of the An-148 regional airliner – conducted a first sortie with the D-436-148FM turbofan on 5 February.

Ground tests of the powerplant had previously been completed at a facility in Zaporozhye, Ukraine.

The D-436-148FM's thrust has been uprated by 6.7% to 15,500lb thrust (68.8kN) for the take-off phase. Another pre-production An-178 is undergoing rig-based fatigue trials at the Ukrainian airframer's Kiev facility.

Antonov has secured preliminary orders for 30 of the type from Saudi Arabia's military and a further 10 from Azerbaijani cargo carrier Silk Way West Airlines. ■

MANUFACTURING **TOM ZAITSEV** MOSCOW

Resurrection of Il-114 gathers pace

Ilyushin is finalising plans to restart manufacturing of its mothballed Il-114 regional turboprop.

The 64-seat aircraft will be built at the Sokol aviation plant in Nizhny Novgorod at a rate of 18 per year, says Ilyushin general director Sergei Velmozhkin.

"We've already freed up space for it, completed re-planning and are ready to make tooling and rigs. We're looking to test run the assembly line in 2017 and roll out a first aircraft in 2018," Velmozhkin says.

Plant director Alexander Karezin says Sokol and Ilyushin have jointly agreed a business plan and secured tentative funding for the production programme.

> **"We've... completed re-planning and are ready to make tooling and rigs. We're looking to test run the assembly line in 2017"**
>
> **ALEXANDER KAREZIN**
> Director, Sokol aviation plant

Airteamimages

Production of 64-seat turboprop will take place at Sokol factory

"In the same vein, we've concluded a general agreement with other enterprises of [Ilyushin parent] United Aircraft, which collaborate in the project, and third-party suppliers," Karezin adds.

Ilyushin is also negotiating to acquire Il-114 aerostructures currently in storage at former affiliate TAPO's facility in Tashkent, where the aircraft were previously built.

Il-114 production in Uzbekistan ceased in 2012, when the TAPO plant was converted for other uses. ■

Lisbon grabs back TAP
AIR TRANSPORT P14

INVESTIGATION **DAVID KAMINSKI-MORROW** LONDON

Poland re-opens old wounds

Warsaw risks fresh rift with Russia with new inquiry into 2010 crash of presidential Tu-154

Poland's defence ministry has formally approved restarting inquiries into the Tupolev Tu-154 crash at Smolensk which killed the country's then-president and dozens of senior officials.

Its decision follows last year's Polish parliamentary election, in which the Law and Justice party emerged victorious. The party is chaired by Jaroslaw Kaczynski, the brother of the deceased president Lech Kaczynski.

Russian investigators conducted an extensive analysis of the April 2010 accident, against a background of deep suspicion between the two sides.

President Kaczynski had been travelling to Smolensk with a high-ranking delegation for a sensitive commemoration ceremony at Katyn, the site of a Second World War massacre of Polish prisoners by Soviet agents.

The inquiry by Russia's Interstate Aviation Committee concluded that the Tu-154 had descended below safe altitude in low-visibility conditions, and that its crew had failed to respond to terrain warnings.

There was no evidence of a fire or explosion on board the jet before the crash. The Russian investigation determined that the pilots had been under psychological pressure, from senior military personnel present in the cockpit, to attempt the approach rather than divert.

REX/Shutterstock

A previous safety probe attributed Tupolev accident to pilot error

But despite the strong evidence supporting the inquiry's findings, the Polish defence ministry – which was sharply criticised by investigators – appears determined to re-analyse the events.

The new subcommittee will be chaired by aviation engineer Waclaw Berczynski.

Defence minister Antoni Macierewicz says a resumption of the investigation "will allow us to find out what happened", and identify those responsible.

He suggests the organisation of the original inquiry committee was flawed. Macierewicz claims a previous Polish commission, headed by then-interior minister Jerzy Miller, pointed to "numerous irregularities" and "errors" relating to the course of events. ■

SAFETY
DAVID KAMINSKI-MORROW LONDON

Departing DAT crew lined up with edge lights

Investigators have disclosed the crew of a Danish Air Transport ATR 72-200 erroneously lined up with the runway edge lights during a take-off incident at Karup.

The aircraft (OY-LHA) had been operating a domestic service, flight DX171, to Copenhagen on 25 January. DAT previously confirmed the aircraft hit edge lights during the take-off roll, without giving more detail.

But French investigation authority BEA, citing preliminary information from its Danish counterpart, says the pilots aligned the aircraft with the edge lights "in the mistaken belief they were the runway centreline lights".

As the turboprop accelerated along runway 27L its nose-gear and a main-gear assembly hit the edge lights and an arrester cable, it adds. The take-off was aborted.

Karup would have been in darkness at the time of the incident and weather data indicates low visibility as a result of fog. The extent of any damage to the aircraft has not been disclosed.

Flightglobal's Fleets Analyzer database lists the aircraft as a 20-year old airframe. ■

MANUFACTURING **STEPHEN TRIMBLE** WASHINGTON DC

ACAE selects first Western supplier for CJ-1000A

GKN Aerospace is to supply components for the ACAE CJ-1000A engine, becoming the first confirmed Western supplier to China's first indigenous high-bypass turbofan. The UK-headquartered manufacturer will supply low-pressure turbine shafts to Chinese engine maker ACAE from a facility in Norway, it says.

Neil McManus, senior vice-president for Asia at GKN Aerospace, calls the deal a "milestone first agreement" with ACAE, which he describes as "an important customer. This is a major programme in a key market".

Development of the CJ-1000 began five years ago with the goal of producing a domestic alternative to the CFM International Leap-1C engine to power the Comac C919 narrowbody.

GKN has released a cutaway revealing more details about the interior architecture of the CJ-1000A. It appears to feature an eight-stage high-pressure compressor driven by a two-stage high-pressure turbine.

The programme has attracted interest from Western suppliers, but GKN is the first to announce a confirmed supply contract.

Germany's MTU Aero Engines worked with ACAE in 2012 to study the life cycle of the CJ-1000A, evaluating the design feasibility. But MTU has announced no further involvement.

Last year, Russian engine supplier United Engine Corporation revealed it had signed an agreement with ACAE to study a role on the CJ-1000A, but no progress has been announced. ■

REX/Shutterstock

China is developing an alternative engine to the Leap-1C

ENVIRONMENT

ICAO to tighten greenhouse gas emission rules

ICAO's governing council is set to formally adopt a new carbon dioxide emissions standard for civil aviation which will come into effect from as early as 2020.

New deliveries of all aircraft types under current production will have to adopt the standard from 2023, with a phase-in scheme which will cut off in 2028.

The standard will be "especially stringent" for larger, long-haul aircraft, says ICAO, addressing the area of "greatest impact".

ICAO claims 90% of international aviation emissions are generated by aircraft weighing over 60t. The standard, which the ICAO committee on aviation environmental protection has unanimously recommended, will apply to new aircraft designs from 2020.

The proposed standard will be submitted to the 39th ICAO assembly in September for endorsement, and then put to the 36-member ICAO council in early 2017. "Every step in support of ICAO's full basket of measures for environmental improvement is an important one," says council president Olumuyiwa Benard Aliu. ■

OWNERSHIP **DAVID KAMINSKI-MORROW** LONDON

Lisbon grabs back TAP stake

Atlantic Gateway consortium agrees to reduce 61% shareholding in Portuguese flag carrier

Portugal's socialist government has provisionally succeeded in taking back part of the shareholding of TAP Portugal divested to private investors last year, giving the state a 50% stake in the airline.

Private investment consortium Atlantic Gateway has agreed to a rebalancing of ownership under a memorandum of understanding signed in Lisbon.

Atlantic Gateway had sealed an agreement to take 61% of TAP towards the end of last year, just as Portugal underwent a transition to the current socialist government under prime minister Antonio Costa.

The government says it will pay €1.9 million ($2.1 million) to increase its share from 34% to 50%, leaving Atlantic Gateway with 45%, and the remaining 5% open for purchase by employees or the consortium.

Under the memorandum – which sets a 30 April deadline for a firm contract – the transaction maintains the €10.93 per share price established in last year's privatisation process.

AirTeamImages

Two parties will stick to a business plan agreed last November

Talks between the two sides were "not easy", says Costa, but he insists there was "never a conflict" between the state and TAP investors.

He adds that TAP will remain a private company and the government will not interfere with its day-to-day management.

The government insists it has "regained strategic control" of TAP, and Costa says the new structure is "essential" to ensure the carrier's role in serving Portugal's economy.

Atlantic Gateway is headed by entrepreneur Humberto Pedrosa, who says the airline will remain under private management, but there is a "guarantee of stability" for the carrier and staff through the partnership. The agreement will "contribute to the strengthening" of TAP, he adds.

The pact will allow the government to claim a degree of success in its objective of renationalising the carrier. Portugal's government and Atlantic Gateway have declared, in the memorandum, an intent to keep to the business plan which the investors put in place last November. ■

CARGO **ALEX DERBER** LONDON

ASL Aviation to grow on back of TNT-FedEx merger

ASL Aviation is to acquire TNT Airways and Pan Air as part of the fall-out from the acquisition of TNT Express by US logistics giant FedEx.

European Union aviation rules stipulate that Memphis-headquartered FedEx must divest the two cargo airlines to meet rules on foreign ownership.

These state that European carriers must be majority-owned by citizens of EU member states.

Irish-based airline group ASL – which operates scheduled, charter, ACMI and cargo services – will acquire TNT Airways and Pan Air for an undisclosed sum upon completion of the FedEx-TNT Express deal, expected in the first half of 2016.

AirTeamImages

Carrier's 25-strong fleet includes Boeing 747-400 freighters

Weeks prior to the announcement, ASL had arranged $110 million of funding from BNP Paribas and Lloyds Bank to support its expansion.

If ASL's deal proceeds, it will add 34 freighters to its current fleet of more than 100 aircraft and assume wet leases of a further 20 from TNT.

Liège-based TNT Airways operates a total of 25 aircraft – a mix of Boeing 737, 747, 757, 767 and 777 freighters – Flightglobal's Fleets Analyzer database shows, while subsidiary Pan Air has nine BAe 146s.

These will continue to serve TNT Express under a "multi-year" deal that makes ASL a "preferred neutral aviation services provider" to FedEx-TNT.

"This means we treat every customer as if they are our only customer – we don't treat one better than another," says ASL's director of corporate affairs, Andrew Kelly. It will continue to serve multiple clients, he adds. ■

XTI Aircraft, Sikorsky

The TriFan 600 (*top*) promoted by Pino (*right*), and the Sikorsky X2 which paved the way for innovative S-97 Raider

A man with big ideas

Retired army master aviator and former Sikorsky head Jeff Pino will have a lasting legacy after family establish a foundation in his name – and through the TriFan 600 project he championed

Former Sikorsky president Jeff Pino died on 5 February, when his North American P-51D Mustang crashed in Pinal County, Arizona. The owner of the warbird – nicknamed "Big Beautiful Doll" – and passenger Nicholas Tramontano were killed in the accident.

As news of the crash spread, dozens of tributes to the late aerospace executive spread on social media, *writes Stephen Trimble*. Lockheed Martin-owned Sikorsky Aircraft tweeted the company "mourns the sudden loss". In a news release, his former company added: "we remember Jeff as a leader, pioneer, innovator and advocate." The retired army master aviator was well-respected among flyers, particularly in the warbird community. "RIP Jeff Pino. I enjoyed flying with you," tweeted air show display pilot Patty Wagstaff.

Pino struck an unusual profile, as both a top aerospace executive and a highly-skilled pilot with a passion for flying and pushing the boundaries of technology. In addition to his P-51D, he also owned one of the first Eclipse 500 very light jets to roll off the company's Albuquerque assembly line in New Mexico.

"It's a shame more real innovation is so slow in the industry," Pino wrote less than two weeks before his death, in a 26 January "ask me anything" feature published on Reddit.

At a time when Sikorsky was flush with cash due to a spike in military spending, Pino reinvested some of the company's revenues in a bold programme to defeat the roughly 170kt (315km/h) speed barrier imposed on the most advanced helicopters. Subsequent tests of the company's compound, coaxial, rigid-rotor X2 validated a design capable of surpassing 250kt in level flight, and paved the way for the launch of the internally-funded S-97 Raider demonstrator and a collaboration with Boeing on the SB-1 Defiant, which is in development.

In retirement, Pino found another outlet for pursuing innovation in the aerospace industry from an unlikely source, joining with oil-and-gas industry attorney David Brody – another passionate pilot with an entrepreneurial streak – as vice-chairman of XTI Aircraft, a new company proposing a vertical take-off and landing business jet powered by three ducted fans.

The approach to the TriFan 600 concept involved launching a campaign through crowdfunding website startengine.com last August to promote interest and raise crucial financial backing.

Pino described the response as "overwhelming", with more than 2,000 expressions of interest lodged totaling support worth around $20 million. This, he said, was a "revelation" for a start-up company where securing funds from banks, private equity and high-net-worth individuals presented a real challenge.

Paying tribute to his colleague and friend, Brody summed him up as "a brilliant strategist, visionary and expert in all things aviation. A man with big ideas, and even bigger dreams."

In a statement, his family described his life as "one of leadership and innovation", and announced the establishment of the Jeff Pino Foundation. This will raise funds to support "Veterans, the Red Cross, EAA, the University of Arizona and other efforts that help, support and mentor young people who aspire to become pilots and pursue careers in aviation, aerospace, and science, technology, engineering and math. This was one of Jeff's dreams and will be his legacy."

Speaking to *Flight International* last month, Pino explained why he was staying involved with the industry after retiring from Sikorsky. "Aircraft are in my blood," he said. "They have always been my passion." ■

Jeff Pino, 1954 – 5 February, 2016

PROCUREMENT **JAMES DREW** WASHINGTON DC

US budget places readiness ahead of modernisation

Slowed pace of Lightning II production among trade-offs to support operations, but tanker and bomber projects secure

Aviation procurement has been reduced by 7.2% to $45.3 billion in the US Department of Defense's fiscal year 2017 budget submission, with 298 new aircraft requested, versus an enacted 527 in FY2016.

The requested lower funding level will buy eight fewer fixed-wing aircraft for the US Air Force – five Lockheed Martin F-35As and three Lockheed C-130Js, and remove 35 rotorcraft for the army and navy versus the number afforded in the current budget, say DoD officials. These will, respectively, lose 24 Sikorsky UH-60 Black Hawks and nine Boeing AH-64 Apaches, and two Bell Boeing V-22 Osprey tiltrotors from the FY2017 procurement account.

Detailed on 9 February, the budget does protect other high-priority air force procurements, including of 15 Boeing KC-46A tankers and Northrop Grumman long-range strike bomber. It also seeks two additional F-35s and two Boeing F/A-18E/F Super Hornets to replace combat losses.

Worth $582.7 billion, the DoD's entire spending proposal for the year to 30 September 2017 conforms with a bipartisan budget deal passed late last year, and is $17 billion below the spending levels projected in last year's request.

Deputy secretary of defence Robert Work says that in crafting the budget, the Pentagon focused on shape, not size and modernisation, versus readiness for today's conflicts.

Work foresees a return to "large power competition" over the next 25 years, similar to the conditions seen during the Cold War, and sees global terrorism as remaining a long-term threat. He raises particular concern about North Korea's pursuit of the KN-08 intercontinental ballistic missile, which would be capable of reaching the US mainland if successfully fielded.

Work warns that the current plan requires significant new funding in FY2018, after the budget agreement reverts back to enacted sequestration levels, meaning that many of the toughest budget trade-offs and decisions will be left to the next administration, in 2017.

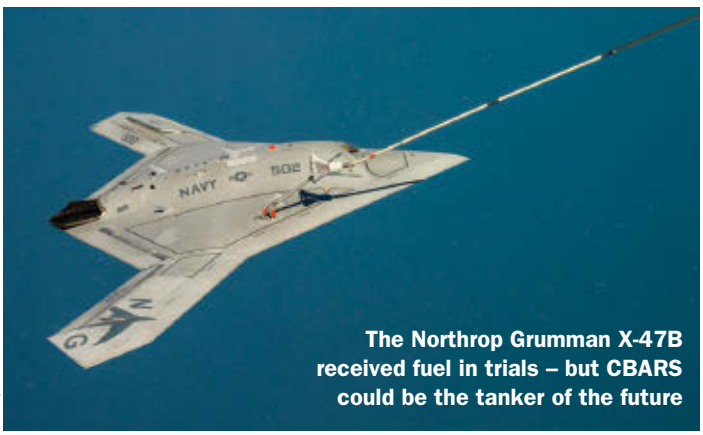
As part of the plan, the USN has proposed deactivating its 10th Carrier Air Wing at NAS Lemoore in California, with its remaining aircraft to be spread among other units. It is requesting $14.1 billion to procure 94 aircraft in FY2017: 42 rotorcraft, 41 fixed-wing aircraft and 11 unmanned aircraft. This is down from 153 in FY2016; reflecting the end of its Lockheed/Sikorsky MH-60R procurement.

Overall, rotorcraft orders were the main casualty, falling from an enacted 316 helicopters and tiltrotors in FY2016 to 152 in the new request.

The USAF's aircraft procurement account takes the biggest hit in the budget, at $13.9 billion; down 12% compared with $15.8 billion in FY2016. The service will shift the procurement of 45 F-35As out of its five-year funding profile: the equivalent of four fighter squadrons. Instead, it will spend $3.4 billion to keep the Fairchild Republic A-10 operational through 2021, and

UNMANNED SYSTEMS **JAMES DREW** WASHINGTON DC

Review refuels unmanned concept as reconnaissance and tanking platform



US Navy

The Northrop Grumman X-47B received fuel in trials – but CBARS could be the tanker of the future

The US Navy's long-running attempt to field a carrier-based unmanned combat aircraft has taken another turn, morphing from a surveillance and strike asset into a reconnaissance and aerial refuelling platform with "limited strike capability".

The about-turn follows a top-level review and restructuring of the now-defunct unmanned carrier-launched airborne surveillance and strike (UCLASS) project, with the service's latest budget instead funding the RAQ-25 carrier-based aerial refuelling system (CBARS).

According to budget documents, $1.1 billion has been committed to UCLASS through fiscal year 2016, supporting actvities including carrier-based demonstrations of the Northrop Grumman X-47B. About $435 million was enacted by Congress for FY2016, but CBARS takes form with just $89 million in the FY2017 budget submission.

Total funding for CBARS will be $2.2 billion through 2021, and a competition and downselect of an air vehicle provider has been delayed by approximately one year, to

SHieLD laser pod could be in demonstration by 2021
DEFENCE P18

US Air Force

Five F-35As have been trimmed from expected fiscal year 2017 order

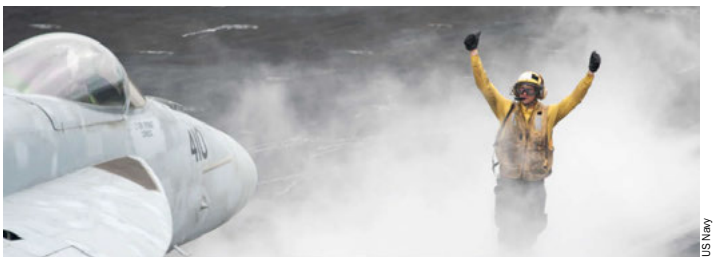
PROGRAMME **JAMES DREW** WASHINGTON DC

Navy maintains Super Hornet's sting

The US Navy has sought more Boeing F/A-18E/F Super Hornets by funding two aircraft in fiscal year 2017 to replace combat losses, and another 14 in FY2018 to maintain capacity as its older Hornets wear out.

Concerned about a shortfall in structurally-sound strike fighters, the navy has accelerated its procurement of Lockheed Martin F-35s by funding 64 carrier-based C models by 2021 – eight more than previously planned – and keeping Boeing's Super Hornet line in St Louis, Missouri active amid a lack of exports.

Boeing is counting on the USN to sustain production of its Super Hornet variants, also including the EA-18G Growler electronic-attack model, as it attempts to muster 24 orders per year to keep the line viable.



US Navy

Boeing needs the USN's F/A-18E/F orders to maintain production

The navy has budgeted $185 million in its wartime budget for two aircraft in FY2017, and included $1.3 billion in its FY2018 projects for the extra 14.

By contrast, the US Air Force has not lent a helping hand to the Boeing F-15E and Lockheed F-16 production lines by ordering further examples, although it will begin retrofitting the latter with new active electronically-scanned array radars.

Defence and aerospace analyst Wayne Plucker, of Frost & Sullivan, says the F-16 and F-15 will remain viable combat platforms when supported by packages of fifth-generation Lockheed F-22s and F-35s. ■

the planned retirement of the EC-130H Compass Call has also been delayed to meet persistent operational demands.

"The decision to delay modernisation was taken to pay for capacity and readiness," the USAF says. "These deferments are not programme cuts," it adds.

An allocation of $3.6 billion will enable the US Army to buy aircraft including 48 AH-64Es (down 25%), 36 UH-60Ms (-66%) and 22 Boeing CH-47 Chinooks (-43%). The service requested $5.9 billion for aviation procurement in FY2016. ■

2017, compared with the UCLASS schedule. Northrop, Boeing, General Atomics Aeronautical Systems and Lockheed Martin are vying to build the refuelling platform, expected to reduce dependence on Boeing F/A-18E/F Super Hornets in the role.

"The mission of tanking is going to be critical to making the air wing more effective and projecting power forward, but the long-endurance [surveillance and targeting] is going to be critical as well," says Rear Adm William Lescher, the navy's deputy assistant secretary for budget. ■

Five-year cut to F-35A procurement

A US Air Force decision to reduce annual procurement of the Lockheed Martin F-35A Lightning II to 48 per year has been played down by the head of the multinational programme, Lt Gen Christopher Bogdan.

According to the service's fiscal year 2017 budget submission, 45 fewer F-35As will be sought over the next five years. Overall, 36 fewer aircraft will be acquired by the US services between 2017 and 2021, after adjusting for increased F-35B and F-35C purchases for the Marine Corps and navy, respectively. A previously planned ramp-up to 60 units per year would be deferred from FY2018 to FY2021.

Bogdan calculates that the USAF's adjustments will not impact the overall unit price of the F-35 by more than 1%. His programme office counts US and international orders for 873 units from 2016 to 2021: a net reduction of 20 from last year's plan. US purchases will account for 54% of this total – which for now includes assumed aircraft for Canada, which late last year pledged to withdraw from the programme and launch a new competition to replace its Boeing CF-18s.

"We have all kinds of puts and takes with our eight partners and three [foreign military sales/FMS] customers, both in 2017 and in the future," Bogdan says. "Relative to the cost of the airplane and FMS commitment, it's a non-news event."

Other commentators are not so sure. Gen Larry Spencer, who retired last October as air force vice chief of staff, says the orders trend is reminiscent of the budgetary "death spiral" that contributed to the premature end of its Lockheed F-22 and Northrop Grumman B-2 procurements.

"I remember when the F-22 decision was made, the rationale was that we had the F-35 coming," Spencer tells *Flight International*. "Okay, well here we are, and we're starting to slip it."

The USAF, which still wants to acquire a total of 1,763 F-35As, says the proposed deferments will pay for "capacity and readiness for today's fight".

FISCAL YEAR 2017 BUDGET REQUEST

Combat aircraft	
F-35A	43 (-4)
F-35B	16 (-1)
F-35C	4 (-2)
F/A-18E/F	2 (-3)
Special mission	
E-2D	6 (+1)
EA-18G	0 (-10)
P-8A	11 (-6)
Tanker	
KC-46	15 (+3)
KC-130J	2 (-)
Transport	
C-130J	12 (-15)
Combat helicopters	
AH-64E	52 (-12)
CH-47F/G	22 (-17)
CH-53K	2 (+2)
MH-60R/S	0 (-29)
UH-1Y/AH-1Z	24 (-5)
UH-60M	36 (-71)
UH-72	0 (-28)
V-22	16 (-4)
Unmanned systems	
MQ-1C	0 (-17)
MQ-4C	2 (-2)
MQ-8C	1 (-4)
MQ-9	24 (-9)
RQ-7/20	8 (+2)
Total	**298 (-229)**

SOURCE: US Department of Defense
Figures show requests for fiscal year 2017, and unit change from FY2016 enacted total

EQUIPMENT **BETH STEVENSON** LONDON

BAE Systems keeping Striker II order in its sights

Development of BAE Systems' Striker II helmet-mounted display (HMD) is due to end in the coming months, after a flight-test campaign to validate its integrated night vision capability.

Night-time sorties have been conducted since May, and the remaining development work is set to finish soon, the company says.

"We're just finishing off the last piece, and expect a full system to be ready by the end of the second quarter," says Mark Bowman, chief test pilot at BAE.

Striker II was developed as an alternative HMD for the Lockheed Martin F-35, but dropped for a Vision Systems International design. The new digital Striker has been qualified on the Eurofighter Typhoon, but is yet to gain a production contract. An analogue version, requiring separate night vision goggles, is used by Typhoon operators, but production will end in 2016, having averaged 12 units per month, and risen to 22 per month in 2015.

BAE is confident Striker II will be adopted, and is looking at technology for incorporation, plus incremental upgrades. These include control methods such as eye tracking and blink control, and the use of medical, sport and neurological technology.

"The company is very forward-leaning. There is a lot of investment in future technology," says Bowman. He notes that the UK's Strategic Defence and Security Review last November affirmed the relevance of the Royal Air Force's Typhoon fleet to 2040. This should mean a sustainment contract for the service's current analogue Strikers, along with future capability updates or even the acquisition of a new design. ■

HMD has undergone night vision testing with the Typhoon

BAE Systems

MODIFICATION

TUSK proposal will strengthen Warthog fleet

Recently spared early retirement, the US Air Force's Fairchild Republic A-10 fleet has had a further boost, via a wing replacement programme which could keep the type flying beyond its 2021 out-of-service date.

According to contracting notices, the A-10 thick-skin urgent spares kitting (TUSK) wing assemblies programme could deliver up to 120 wings, at an annual rate of 10 to 25 units, over five years.

A previous USAF contract with Boeing and Korea Aerospace Industries, covering 173 replacement wings and options for 69 more, is set to conclude in September. Representatives from the former, plus Israel Aerospace Industries, Lockheed Martin and Spirit AeroSystems, attended an industry day at Hill AFB in Utah last November about the follow-on requirement.

The air force's fiscal year 2016 budget includes funding for a first wing, plus three low-rate initial production units. The service maintains an operational fleet of 284 A-10C Warthogs, with an average age of 34 years. ■

ARMAMENTS **JAMES DREW** WASHINGTON DC

SHieLD laser pod could be in demonstration by 2021

Advanced technology programme could enable fighters to destroy incoming missiles

The US Air Force Research Laboratory (AFRL) will gather market information about a podded electric laser system, which could demonstrate by 2021 whether fifth- and sixth-generation fighters can destroy, rather than divert, incoming missiles.

Under an advanced technology demonstration programme called self-protect high-energy laser demonstrator (SHieLD), the effort seeks to integrate a "moderate power" electric laser into a protective pod on types such as the Lockheed Martin F-22 and F-35.

"SHieLD seeks to expand moderate power (tens of kilowatts) laser weapon operation into the supersonic regime by demonstrating system performance under transonic flight, and acquiring aero-effects data under a supersonic environment relevant to tactical aircraft," the AFRL says in a request for information. "Advanced laser options under investigation are those with size and weight appropriate for integration as part of a complete weapon system into an aerodynamic integrated pod-like structure."

Scientists hope to validate the pod in a laboratory by 2017 and demonstrate a prototype by 2021, the AFRL says. The US Special Operations Command also wants a laser weapon on the Lockheed AC-130J gunship by 2020. ■

The US Air Force's F-22 could be equipped with a high-energy defensive capability under the plan

US Air Force

Italian F-35 makes Atlantic crossing
NEWS FOCUS P20

SAFETY JAMES DREW WASHINGTON DC

US Navy targets Hornet hypoxia rate

New filtration systems on F/A-18s to remove contaminants from pilots' oxygen, as decompression sickness reports continue

Efforts to overcome high rates of hypoxia and decompression sickness in pilots flying Boeing F/A-18 variants is "like chasing a ghost", says the US Navy's director of air warfare, while adding that he remains confident in the aircraft and its oxygen back-up systems.

Since 2010, F/A-18 pilots have been asked to report every physiological event – such as dizziness or confusion – because of suspected problems with the aircraft's onboard oxygen generation systems (OBOGS) and environmental control system (ECS).

Those rates have been consistently high over the past six reporting periods, with an average of 19.7 cases per 100,000 flight hours for early-model F/A-18s and 20.4 for the newer E/F-model Super Hornet. The average figure is 8.9 events per 100,000 flight hours for EA-18G Growler pilots, except for a "statistical anomaly" in 2015, when 43.5 cases were reported.

On 4 February, Rear Adm Michael Manazir told a congressional hearing on naval strike fighters that it is difficult to come up with a materiel solution without knowing the exact cause of the problem, adding that there are no onboard sensors to record carbon monoxide or contaminant levels.

Multiple changes have been made to the aircraft's environmental control system

US Navy

"We're trying to get the rate down," Manazir says. "If we had a confidence problem in the airplane we would ground the fleet, but we don't have that problem."

Director of navy tactical aircraft Rear Adm Michael Moran says 18 or 19 changes have been made to the ECS, including new pressure and control valves and sensors to deal with possible causes of decompression sickness.

New filtration systems have been installed in the OBOGS of 219 aircraft to better remove carbon monoxide and other contaminants from the pilot's oxygen. Those filters will eventually be rolled out across the F/A-18 fleet, and testing of a new oxygen monitoring system should conclude this year, for installation in 2017.

"We're getting good test results on removing the carbon monoxide, and are doing a study to see what else is there," Moran says.

Manazir says he has full confidence in the F/A-18's back-up oxygen system. "It has worked 100% every time, and I'm confident it still will," he says. ■

PROCUREMENT BETH STEVENSON LONDON

Paris finalises short-notice C-130J tanker purchase

France has confirmed its purchase of four Lockheed Martin C-130J Super Hercules tactical transports, including two that will be configured to refuel its military rotorcraft.

A contract for the acquisition was signed on 29 January; two months after the US Defense Security Cooperation Agency (DSCA) had announced Congressional authorisation for the proposed deal.

Ordered through the US Air Force via the US government's Foreign Military Sales programme, the transport-roled C-130Js will be delivered in 2017 and 2018, France's DGA defence procurement agency says. The extended-range KC-130J tankers will follow during 2019.

The new aircraft will complement a French air force transport inventory which Flightglobal's Fleets Analyzer database records as including 31 C160R Transalls and 14 C-130Hs. It also has received eight of an eventual 50 Airbus Defence & Space A400Ms: a type which has so far proved unsuitable for refuelling rotorcraft in-flight.

The DSCA last November valued the four-aircraft deal as worth an estimated $355 million, also including personnel training, in-service support and four spare Rolls-Royce AE 2100D turboprop engines. ■

DEPLOYMENT **JAMES DREW** NAS PATUXENT RIVER

Italian F-35 makes Atlantic crossing

Domestically-assembled Lightning II completes historic journey from Cameri air base, with tests and training duties ahead

An Italian air force test pilot made history on 5 February, by completing the maiden trans-atlantic crossing with the stealthy, single-engined Lockheed Martin F-35A Lightning II.

The pilot – identified as Maj Gian Marco D – took off from Lajes Field, the Azores at 07:30 local time, in Italy's lead example of the conventional take-off and landing type. Named AL-1, and carrying the registration MM7332 for the Italian air force's 32nd Wing, this touched down at NAS Patuxent River in Maryland almost 7h and more than 2,000nm (3,700km) later.

Completing the first transatlantic crossing with the new type was a moment of national pride for Italy. After triumphantly unfurling his nation's flag from the cockpit, the pilot was greeted by top generals from its air force, who had travelled aboard a Boeing KC-767 tanker/transport that refuelled the fighter four times en route.

"The first aircraft to cross 'The Pond' is Italian, flown by an Italian, with Italian support. We're not following somebody in this. We're on the very front line," Marco says.

Lockheed Martin

Conventional take-off and landing AL-1 made a 7h transit from the Azores to NAS Patuxent River

> **"The first [F-35A] to cross 'The Pond' is Italian, flown by an Italian, with Italian support"**
>
> **MAJ GIAN MARCO D**
> Italian air force

FORMATION

"We're making history here because we built it, we're flying it, we're supporting it; because we're here at the very same level with America. We should be proud as a nation of that."

AL-1 also was accompanied by two Italian Eurofighters and a second KC-767, which were heading to the USA to participate in a Red Flag exercise, and split off to land at Pease Air National Guard Base in New Hampshire. Two Lockheed C-130J tactical transports also flew with the group, carrying life rafts in case any of the fighter pilots were forced to eject.

"We kept a tight formation," Marco says. "[The C-130s] guaranteed us 30min to 60min time before they drop you a big raft."

The formation spent 5h of the 7h flight time in poor meteorological conditions, facing headwinds of up to 120kt (222km/h) while flying to St John's, Newfoundland. The F-35 and its tanker then headed south from Canada along the US East Coast, passing through a warm front with moderate to severe turbulence.

"The first [refuelling] was in cloud, the second was in cloud, the third was in turbulence – but we had 100% success," Marco says. "There were no [tanker] disconnections. The F-35 is really, really stable. The flight control system is very impressive, because it's really easy to stay back there and enjoy the ride." The fourth refuelling was conducted as a precaution, before landing.

The previous leg of the journey – from Italy's final assembly and check-out (FACO) facility for the F-35 at Cameri air base to Lajes Field – was conducted on 2 February, with three in-flight refuellings. The onward journey was then delayed by two days, due to poor weather.

Marco says AL-1 is a more mature model than the aircraft he flew prior to graduating from the multinational F-35A pilot school at Luke AFB in Arizona last November, and that he had complete confidence in it.

Assembly work on the first production example to roll off the Italian line began in July 2013, with its first flight achieved last September.

"We had the chance to fly for 15h with the KC-767 before crossing. In 6h for the first flight and 7h for the second one we had no issues, and I mean zero," Marco says. "We have 1,100 young workers at the FACO working as a team for this result, together with the operational wings and the air force," adds the former Panavia Tornado pilot, who now has 80h of flying time on the F-35.

The Cameri plant is owned by the Italian government, but operated by Finmeccanica company Alenia Aermacchi. It will deliver as many as 60 F-35As and 30 short take-off and vertical landing F-35Bs for the Italian air force and navy, and also assemble aircraft for the Netherlands.

AL-1 will remain at NAS Patuxent River for the next two to three months, for electromagnetic environmental effects (E3) testing. This will involve placing it inside an anechoic chamber, where US Naval Air Systems Command engineers will subject it to every possible electromagnetic waveform that it could encounter during operational use.

TRAINING

"We want to make sure when this plane flies by a SPY-1 [ship-based] radar or an air search radar that we do not have anomalies," says E3 site director Kurt Sebacher.

Once this phase has concluded, the aircraft will be flown to Luke AFB, as one of an eventual five Italian F-35As to support a training programme also involving pilots from Joint Strike Fighter partner nations Australia, the Netherlands and the USA, plus foreign military sales customers Israel and Japan. ■

See Feature P24

New designs fail to lift sagging sales
BUSINESS AVIATION P22

RESEARCH **BETH STEVENSON** LONDON

Hurricane-hunting Coyote set for duty

Raytheon's tube-launched Coyote unmanned air vehicle is to continue its role in tracking hurricanes for the US National Oceanic and Atmospheric Administration (NOAA), following an upgrade that has increased its endurance and range.

The Coyote – an expendable system – was the first UAV to be flown directly into a hurricane, in 2014, when it was launched from the belly of a NOAA-operated Lockheed Martin P-3 Orion into Hurricane Edouard.

"We are under contract with NOAA to support development and initial use of Coyotes in the hurricane research programme," John Hobday, business development lead for Raytheon Unmanned Systems, tells *Flight International*. "This is an ongoing collaborative development with NOAA for several years that is now going operational."

Raytheon says "significant improvements" have been made to the Coyote, which it acquired from BAE Systems in January 2015, increasing endurance to 1h and range to 50nm (92km) from the launch aircraft.

Raytheon

NOAA and Raytheon will use the expendable type to track storms

"In terms of range, the only limiting factor is maintaining communications with the Coyote relaying back atmospheric sensor data," Hobday says. Another capability rise is due later this year, Raytheon notes.

A joint NOAA/Raytheon team will use the Coyote to track and model storms over the Atlantic Ocean during the hurricane season, which typically runs from June to November.

The Coyote is also being offered to the US Department of Defense for missions including off-board sensing and swarming, Hobday says. ■

ATM **BETH STEVENSON** LONDON

SkyBridge will give UAV users local knowhow

Belgian company Unifly is to launch an airspace management system for unmanned air vehicles that informs users where they can legally and safely operate their aircraft.

SkyBridge incorporates data feeds from open sources including NOTAMs, local airspace regulations and historical data, to provide UAV operators with a map of permitted low-level airspace. It also features the self-separation requirements of each national aviation authority, so that a user knows how close an air vehicle can get to certain structures.

"There is a new party in the ATM [air traffic management] structure that is important," Jurgen Verstaen, chief business development officer for Unifly, told the SkyTech conference in London last month. "We need to have a system right now: we can't wait for an incident to happen." ■

SURVEILLANCE **BETH STEVENSON** LONDON

UK to test Zephyr pseudo-satellites

Ministry of Defence set to trial high-altitude, long-endurance aircraft designed for communications relay and surveillance

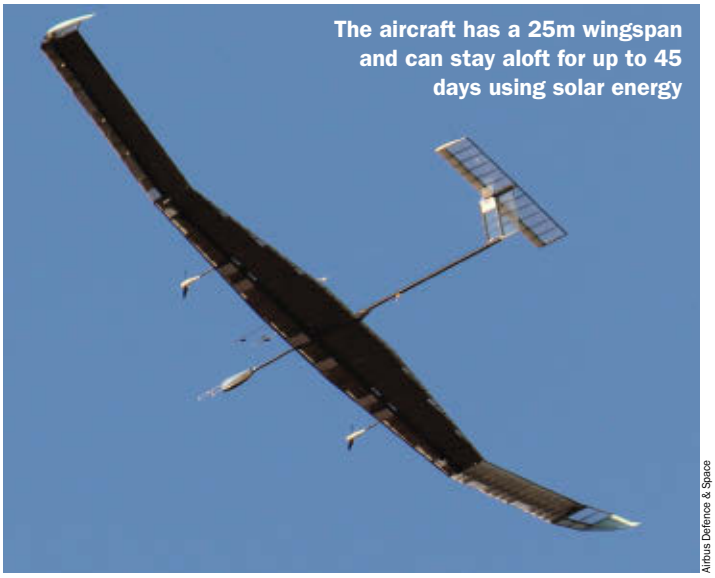
The UK Ministry of Defence expects to sign a £10.6 million ($15.5 million) contract with Airbus Defence & Space in the coming weeks for the manufacture and testing of two Zephyr 8 high-altitude pseudo-satellites.

At the ADS trade association's annual dinner in London on 2 February, secretary of state for defence Michael Fallon said the deal will be signed "as part of our commitment to invest in battlefield communications technology".

Zephyr can stay aloft for up to 45 days, by using solar energy harvested in the daytime to power its systems at night. It weighs 30kg (66lb), including a 5kg payload, has a 25m (82ft) wingspan, and operates at 70,000ft.

First flight of the Zephyr 8 is expected to occur later this year, and two aircraft will take part in an operational concept demonstrator programme during 2017, says the MoD. This will determine if the capability would complement ground operations by providing surveillance and communications relay services.

The UK's plans to invest in the high-altitude surveillance aircraft were revealed as part of last November's Strategic Defence and Security Review.



Airbus Defence & Space

The aircraft has a 25m wingspan and can stay aloft for up to 45 days using solar energy

In a separate development, the MoD has disclosed a dramatic increase in its use of Lockheed Martin AGM-114 Hellfire air-to-surface missiles from the Royal Air Force's remotely-piloted General Atomics Aeronautical Systems MQ-9 Reapers. A respective 93 and 94 Hellfires were fired by the type in 2013 and 2014, as the UK ran down its combat involvement in Afghanistan, but this number jumped to 258 last year, during operations mounted against Islamic State militants in Iraq and Syria. ■

ANALYSIS **KATE SARSFIELD** LONDON

Midsize revives, but other sectors slip

Data from the General Aviation Manufacturers Association shows 2015 deliveries were flat, with several segments falling

The business and general aviation market was flat in 2015, with the revival of the midsize business jet sector – driven by new designs – one of few bright spots.

In its annual industry review, released on 10 February, the General Aviation Manufacturers Association (GAMA) records deliveries of 2,267 fixed-wing aircraft in 2015, compared with 2,376 pistons, turboprops and business jets in 2014. The value of shipments was $20.9 billion – $87 million lower than in 2014.

The business jet sector was the top performer and the only niche to record a year-on-year shipments increase, GAMA says. The data shows 654 deliveries in 2015, compared with 644 a year earlier.

GAMA's report excludes Bombardier's fourth quarter shipments for the last two years to give a like-for-like comparison. The Canadian airframer will release its 2015 delivery figures with its full-year results on 18 February.

Flightglobal's Fleets Analyzer database, however, records a combined 78 Global, Challenger and Learjet deliveries for the final quarter. This tally brings Bombardier's 2015 shipments to 200 – three down on 2014 – and the business jet sector shipments for 2015 to 732 aircraft – 10 more than in the previous 12 months.

"The business jet sector is solid and mature," says GAMA president and chief executive Peter Bunce. "Demand is coming from the US, where the strong economy is triggering a return of corporate buyers and high-net-worth individuals." Bunce's view is supported by Daniel Hall, senior analyst with Flightglobal's Ascend consultancy. "North America saw a 13% new delivery increase, from 374 to 421 units, making 2015 the first year since 2008 where the USA bettered the rest of the world," he says.

2015 BUSINESS & GENERAL AVIATION AIRCRAFT DELIVERIES

	2014	2015
Piston	1,129	1,056
Turboprop	603	557
Jet	722*	732*
Total	**2,454**	**2,345**

SOURCE: General Aviation Manufacturers Association *Includes Bombardier fourth quarter shipments from Flightglobal's Fleets Analyzer database

Textron Aviation

Cessna's figures were boosted by the Citation Latitude's arrival

> **"Demand is coming from the US, where the strong economy is triggering a return of corporate buyers"**
> **PETER BUNCE**
> President and chief executive, GAMA

Growth in business jets in 2015 was precipitated by the introduction of new products, "which are helping re-energise the sector, stimulate customer demand and bolster the fortunes of developers", Bunce adds. His view is supported by GAMA's data.

The introduction of the Citation Latitude last August lifted Cessna's delivery tally nearly 5% in 2015, to 166 units. Sixteen of the midsize jets were shipped.

Embraer's shipment total rose from 116 in 2014 to 120 on the back of the midsize Legacy 500 and its mid-light stablemate, the Legacy 450.

The top-half of the business-jet sector performed sluggishly last year, due to the slump in demand for large, long-distance aircraft from markets such as Brazil and China. GAMA reports 290 shipments of large-cabin, long-range and VIP airliner-sized business jets in 2015, compared with 317 the previous year. Dassault saw the biggest decline, delivering 11 fewer Falcons – a 50% fall year-on-year.

Bombardier recorded a nine-unit fall in Challenger 605/650 shipments to 25 – due in part to the late certification of the upgraded 650, which entered service last November. Deliveries of the high-end Global 5000/6000 fell by seven units to 73 aircraft. Bombardier is readjusting the Global production rate to reflect falling sales.

Gulfstream continued to buck the trend with shipments of its top-end trio – the G450/550/650 - climbing by three aircraft, to 120.

TURBOPROP DECLINE

The turboprop sector was the worst performing fixed-wing segment. Deliveries of single- and twin-engined models slid nearly 8% to 557 aircraft, GAMA reveals. The decline is due to weak demand for agricultural aircraft. Air Tractor recorded a drop in shipments of its AT-family from 145 in 2014 to 114. Similarly, Thrush Aircraft saw the tally of its S2R series fall from 36 to 29.

If the agricultural segment is excluded, the core-business turboprop market remained stable, GAMA reveals. The top performer last year was Cessna's Caravan. Deliveries rose from 94 units in 2014 to 102 last year.

The strength of the single-engined turboprop market prompted Cessna parent Textron Aviation to launch a clean-sheet aircraft last July. The model will be unveiled this year at the AirVenture show in Oshkosh, Wisconsin.

After a 12-month absence from GAMA shipment records, due to the certification effort on its Avanti Evo, Piaggio re-emerged in 2015, recording three shipments.

However, overall shipments of pressurised twin-turboprops fell last year by 7%, GAMA records. Most of the weakness was focused on Beechcraft's entry-level King Airs – the C90GTx and 250. Combined shipments fell by 23 units, to 33 aircraft last year.

Aerospace analyst Rolland Vincent says the top-of-the-range 350i is unchallenged in "a unique market space".

"With Textron's new single-engined turboprop in the works, I would not be surprised if weak delivery output is a signal of the slow demise of the lower end of its King Air line," he adds.

PISTONS PLUMMET

The piston-powered sector fared little better in 2015. Deliveries of single- and twin-engined types fell by 6.5% during this period, to 1,056 aircraft. This compares with 1,129 deliveries in 2014.

With the exception of Cessna, Mooney and Tecnam, which recorded 51-, nine- and one-unit rises, respectively, in 2015 shipments, all the airframers saw a decline in deliveries. Diamond Aircraft disclosed a 46% fall in deliveries of its four-seat DA40 during the period – from 136 to 75 units – while shipments of Beechcraft's Baron and Bonanza fell from 72 to 41 aircraft.

Bunce attributes this decline to a slowdown in demand for private flying and the lack of large contracts for piston-engined aircraft from the global flight training market. ■

Simulated lightning
FEATURE P24

UPGRADE **HOWARD GETHIN** LONDON

Russia works to modernise An-2 with new glass cockpit

Avionics to be replaced on research institute's Antonov biplane as part of update package

Russia's Chaplygin Siberian Aeronautical Research Institute (SibNIA) plans to fit a glass cockpit to a modified example of the 1940s-era Antonov An-2 utility biplane as part of a programme of enhancements to the single-engined turboprop, the institute's chief designer Grigory Anokhin says.

The cockpit will be installed in the institute's TVS-2MS, an An-2 fitted with a Honeywell TPE331 engine and Hartzell five-blade propeller.

"We plan to swap the aircraft's avionics for more modern ones. So far we're looking at imported avionics, but at the same time work is under way with GosNII Aviatsionikh Sistem for creation of a domestic system for such aircraft as the TVS-2MS," says Anokhin.

SibNIA expects to show the first prototype of the modified aircraft with a domestically-produced glass cockpit in March, he says.

If the glass cockpit is a success in the TVS-2MS, it may be installed in the further modified TVS-2DT and other aircraft of this class, he says.

The TVS-2DT is another modification of the An-2 carried out by SibNIA, including some features that could feature on a "future light utility aircraft", a programme being sponsored by Russia's trade ministry.

In 2012, then-deputy trade minister Yury Slyusar – now president of United Aircraft – said modifying the An-2 with a new engine, avionics and airframe life extension was the "quickest route to meeting existing demand" for a new light utility aircraft for Russia's regional air operators. ■

AWARD

HondaJet gets shortlisted for Collier Trophy

Honda Aircraft's HA-420 HondaJet has been nominated by the US National Aeronautic Association for its 2015 Robert J Collier Trophy.

The light twinjet, which entered service late last year, is the only business aircraft in the nine-strong shortlist for a prize awarded by the NAA "for the greatest achievement in aeronautics or astronautics in America".

The other nominees include the Icon A5 light sport seaplane, Airbus A350 commercial airliner and Lockheed Martin's C-5M Super Galaxy military transport. The winner will be unveiled on 8 March. ■

DELIVERY **KATE SARSFIELD** LONDON

AAC celebrates first delivery of presidential 787

US VIP completions and engineering company Associated Air Center (AAC) has delivered the first Boeing BBJ 787-8 to be configured for head-of-state operations. The handover of aircraft TP-01 on 2 February marks the eighth widebody airliner completion performed by the Dallas firm.

It is also the second to the undisclosed customer – believed to be the Mexican government, which in 1989 received the first head-of-state-configured 757-200. That aircraft – previously TP-01 and now re-designated as TP-02 – remains in service.

AAC says the BBJ 787's 223m² (2,400ft²) cabin accommodates 82 passengers in three zones. The fourth, "presidential" cabin has an office, bedroom and en suite bathroom.

AAC is poised to deliver its first BBJ 747-8, and says it is outfitting an Airbus ACJ320 in Dallas. "We are also partnering on other completion projects, and bidding on new wide- and narrowbody contracts," it says. ■

Associated Air Centre

Mexico's air force operates a head-of-state-configured Dreamliner

EXPANSION **KATE SARSFIELD** LONDON

ExecuJet gains toehold in India with FBO approval

Swiss business aviation services provider ExecuJet Aviation will enter the Indian market after receiving permission to build a fixed-based operation (FBO) and maintenance, repair and overhaul facility at New Delhi's Indira Gandhi International airport.

Mike Berry, ExecuJet vice-president for the Middle East, describes the award as "a significant win" for the Luxaviation subsidiary, which has FBOs in 20 locations worldwide and around 100 under management.

"We have had India on our radar for many years," he says. "These new facilities will provide ExecuJet with the platform to expand our geographic footprint and service proposition, in line with our own growth strategy."

ExecuJet has partnered with Indian aviation services company Bird Group to build and support the infrastructure. "A maintenance, planning and engineering team will be in place within three months," says Berry. "The business will be expanded as the managed fleet and customer base increases."

According to Flightglobal's Fleets Analyzer database, India has an installed fleet of 22 business aircraft. However, predicted economic growth is likely to boost demand for business aviation.

Bombardier's latest market forecast, for example, predicts deliveries of over 300 business jets in the light to ultra-long-range categories between 2015 and 2024, spurred by expected GDP growth. ■

US Air Force pilots are starting to transition to the F-35A from legacy types including the F-16

56th Fighter Wing/US Air Force

SIMULATED LIGHTNING

The capabilities of Lockheed Martin's F-35 and the threats it may face in combat are so advanced that the only place to fully prepare pilots is on the ground

JAMES DREW LUKE AFB

The Lockheed Martin F-35 Lightning II is not just one of the most expensive and complex endeavours in military acquisition history, but also an evolution in the way military pilots train to fly jets.

Developed during the computer networking revolution of the 2000s, everything from the way the aircraft is maintained to the way it fights is deeply interconnected, as are its "full-mission" simulators. When a squad of F-35s fly into combat for the first time, the pilots will have already performed their exact mission

against those target objectives dozens, if not hundreds of times in simulators, replicating everything from electronic jamming to the effect of weapons on surface-to-air missile sites.

Not only does the F-35's full-mission simulator provide greater fidelity than previous generations of fighter trainers, it also compensates for the fact it is too expensive to equip every test and training range with the full complement of threats it would be likely to go up against. The only places an F-35 can truly wreak havoc with every kinetic and non-kinetic tool in its beyond-visual-range arsenal will be in the virtual simulator – or in combat.

It is not just belt-tightening that has Lightning II pilots completing 45% to 55% of their initial qualification flights in the simulator – it is the next-generation fidelity and risk-free exposure to the full range of failures or threats, particularly on the electromagnetic spectrum.

Each simulator carries the most recent software load, or operational flight programme, so it can most accurately replicate the capabilities and handling qualities of the aircraft as it is concurrently developed, tested and fielded through various block upgrades.

The simulators arrive in groups of two or four, and will all eventually be plugged into the vast network of US and allied training simulators at air bases and training centres around the world, bringing F-35s into the same virtual environment as Lockheed F-16s, Boeing F-15s, C-17s and others.

According to one air force official, the "Holy Grail" of simulator training will come with the introduction of live, virtual and constructive networking between training devices and aircraft, with blue forces going against aggressors at every level for full-spectrum combat training.

GLOBAL EXPANSION

A dozen nations are seeking upwards of 3,000 F-35s up to 2030, and Lockheed is scaling up significantly over the next five years to accommodate that demand. Though the top priority this year remains the US Air Force's initial operational capability (IOC) declaration for the conventional take-off and landing F-35A variant in August, the UK, Israel, Norway, Turkey, Australia and Italy are also preparing for their first combat-ready squadrons.

This global F-35 expansion is the ultimate test for Lockheed in terms of manufacturing, logistics and in-service support. But equally important is the rollout of the multinational training programme – a monumental task in itself.

The company is already contracted for 209 F-35s through the eighth low-rate initial production lot, and is nearing an agreement for 157 more aircraft in Lots 9 and 10. It has also secured a long-lead materials contract for 91 aircraft expected in Lot 11. Propulsion system supplier Pratt & Whitney is also increasing production, with a handshake agreement for 167 more F135 turbofan engines.

Meanwhile, Lockheed's mission systems and training division has contracts for 87 full-mission simulators plus two options, out of 239 that will be required under the current programme plan. It also has orders for 31 maintenance trainers.

> **"More than half of the initial qualification flights actually take place in the simulator"**
>
> **MIKE LUNTZ**
> Lockheed Martin F-35 training system director

Lockheed will install full-mission simulators at every major F-35 operating location domestically and abroad, and seven sites have already been established across the USA.

The US Department of Defense now has integrated training centres at Eglin AFB in Florida, Luke AFB in Arizona and Marine Corps Air Station (MCAS) Beaufort in South Carolina, and is standing up a fourth exclusively for the F-35C carrier variant at Naval Air Station (NAS) Lemoore in California. Simulators have been delivered to Nellis AFB in Nevada and the first combat-coded F-35 locations, at MCAS Yuma in Arizona (short take-off and vertical landing F-35B) and Hill AFB in Utah (F-35A).

Training centres are being established for each international F-35 operator, depending on their individual requirements. Six international F-35 operators already have pilots and maintainers training in America, including foreign military sales customers Japan and Israel. Lockheed F-35 training system director Mike Luntz tells *Flight International* that full-mission simulator production is ramping up to two units per month in Orlando, Florida. Much like the airframe and engine, a global supply base feeds the line, with industrial input from nations committed to purchasing the jet.

As of 19 January, 24 simulators had been delivered to seven locations, with 63 more on contract through the ninth low-rate initial production lot. For Lightning II maintainer training, the company has delivered 13 aircraft systems maintenance and part-task trainers, with 18 more on order.

"We've got a pretty well-refined production process we've ramped up here in Orlando," says Luntz. "That backlog is to align with customer requirements and delivery dates in their base or country."

It takes about a year to establish a training centre. For instance, Lockheed will begin installing simulators at Israel's Nevatim air base in 2017 ahead of F-35I IOC later that year. In 2018, pilot and maintenance training systems will be installed in Japan, Norway, the UK and Australia.

"We'll be installing the equipment in 2018, to start training activities in 2019," says Luntz.

FULL-MISSION SIMULATION

To date, there are 251 qualified F-35 pilots, including 15 internationals (*see page 29*). On the maintainer side, 2,445 personnel have been qualified to sustain and repair the aircraft, including 2,217 from the US military services and 228 from international forces. As an original programme partner, the UK has made the most headway, with four pilots and 135 maintainers trained and ready.

When a qualifying pilot steps into an F-35 »

US Air Force

There are no two-seat F-35s, so quality simulator training is a crucial precursor to live flying

» for the first time, it won't be with an instructor. One will follow behind in a chase airplane – probably another F-35.

Unlike the F-16 and Boeing F/A-18, there is no twin-seat version of the F-35, so operators rely on quality simulator training. It would certainly be daunting to take control of a high-thrust F-35 for the first time, especially as the aircraft cost taxpayers over $100 million.

There is nothing new about a one-seat combat jet, but the F-35 programme is extremely reliant on its simulators for flight and mission qualification, even compared to Lockheed's F-22 Raptor.

"There is more training being done in the simulators than any other legacy aircraft," says Luntz. "More than 50% of the initial qualification flights actually take place in the simulator."

Former F-16 pilot and commander of the 56th Fighter Wing at Luke AFB, Brig Gen Scott Pleus, says there's "nothing lost" by shifting from legacy "full-motion" simulators to the new "full-mission" simulator, except the jacks and hydraulic actuators. It allows for improved 360° visual displays that incorporate the helmet-mounted display and cueing system and distributed aperture system cameras that give the F-35 unparalleled spherical situational awareness.

"It's by far the most accurate fighter simulator I've seen in my career," says Pleus. "We will rely even more heavily on simulator usage on F-35 because of the level of classification the simulators can give. We won't have a lot of capability to do that in live-fly training.

"The sims can do almost everything we can do in the air, except feel the movement of the actual aircraft," adds Lt Col George Watkins, commander of the 34th Fighter Squadron – the air force's first combat-coded F-35 unit. "From what you see to what buttons you push, you can do everything you do in the air in the simulator. You can actually do more things in the simulator, because we can give ourselves more adversaries, we can give ourselves more threats on the ground to simulate potential adversary countries, and what kinds of things they can shoot at us – as well as tanking, night flying and flying in a larger force package."

Once fully developed, the aircraft will become a frontline hunter, designed to destroy complex, overlapping surface-to-air missile systems, while also guarding against interceptors.

The F-35 is not as manoeuvrable as an F-16, but it compensates with its long-range sensors, weapons and a sophisticated electronic warfare suite – all optimised for beyond-visual-range engagements.

In day-to-day operations, an F-35 must provide air cover to ground troops in contact, or carry out precision bomb raids on pre-planned targets – all the while networking and sharing information with space and cyber assets, as well as other coalition aircraft in the vicinity.

56th Fighter Wing/US Air Force

Brig Gen Pleus: "Most accurate simulator"

Watkins says these missions can be practiced over and over in the simulator, and then again at live test and training ranges or at large-scale exercises like Red Flag.

Suppression or destruction of enemy air defence missions are especially complex, and it is overly expensive to replicate those scenarios in live training environments, he says; particularly electronic warfare.

"That's an advantage F-35 simulators have over legacy," says Watkins. "I know in the F-16 world, we were not able to simulate any type of jamming in the simulators, but that's one of the baseline-standard capabilities that the F-35 brings with it."

FOUR-SHIP TACTICS

When the F-35 goes to war, it won't go alone. As explained by USAF vice chief of staff Gen David Goldfein in a recent televised interview: "Unlike the [Lockheed] F-117, where I would close off the world, the F-35 opens up into the network. It's a networked approach to how we do [the] warfare of the future."

This joint approach to warfare is replicated in the simulators, starting with basic "four-ship" F-35 training at the unit level, and scaling up as those simulators are connected to live and virtual training networks.

According to Col David Lyons, commander of the 388th Fighter Wing, Hill AFB's four simulators were plugged together in December, so now four local pilots can fly together in a single virtual training environment. Today, that environment replicates the local area and Nellis AFB, but it will eventually be loaded with potential areas of operation, populated with the latest Russian and Chinese fighter jets as well, and new types of anti-aircraft weapons and jammers.

"We don't necessarily have that full complement of threats, or the degree of those threats, on our range," Lyons says. "[In the simulator] we have the ability to link everybody together with multiple aircraft and different airplanes of the future, and shape the scenario into a high-end threat [situation] that will challenge even the best of our pilots to be successful. We can't yet achieve that in our range airspace."

> **"The F-35 opens up into the network. It's a new approach to how we do future warfare"**
>
> **GEN DAVID GOLDFEIN**
> US Air Force vice chief of staff

Lyons says the eventual introduction of live, virtual and constructive networking will be transformative in the way pilots train to fight, and US companies are already coming up with ways to do that.

"We'll use our live airplanes on the range and have folks in the simulator contributing to a scenario that is also being flown live," he explains. "We're not there yet, but that's our

US Air Force

At Hill AFB, live-fly training features the newest F-35As, all in weapons grade Block 3F standard

US Air Force

So far, pilots have transitioned from other combat jets, often F-16s, but this year will see some new aviators come straight into F-35s

ultimate goal."

Until now, every pilot operating an F-35 has transitioned across from another combat aircraft community – most having flown the F-16, F/A-18, Fairchild Republic A-10 or McDonnell Douglas AV-8B. This year, the air force and Marine Corps will receive their first newly qualified aviators, who have only limited experience flying combat jets. No doubt, they will be the best and brightest of their classes, but their fast-jet flying experience will be limited.

NEW STUDENTS

Capt Clay Groover, a spokesman for the F-35 programme at MCAS Beaufort, says the Marines' first "Category 1" pilot reported for training duty in December. That student's introduction will help evolve the local training syllabus and open up new avenues for young and ambitious aviators wanting to fly the F-35.

"He just graduated from NAS Kingsville not too long ago," says Groover. "We'll still get some transitioning pilots, but as the pilot training programme keeps evolving and progressing, we're going to get more Category 1 pilots out here."

The newly-minted flight officer will receive basic classroom academics and computer-based flight training before strapping into the full-mission simulator and aircraft.

"The best of the best get to come out here and train on the F-35," says Groover. "We've also trained over 500 maintainers, who are important to keep the thing in the air."

He says training at MCAS Beaufort will ramp up by 25% over the next four years, and the local marine fighter-attack training squadron (VMFAT-501) hopes to have 60 pilots graduate in 2016. This includes a handful of British pilots, since the UK is the largest foreign F-35B customer, with plans to purchase 138 for the Royal Air Force and Royal Navy.

Luke AFB will receive its first new graduate, or "basic course" student this summer ,following his or her introduction to a fighter fundamentals course. That student will have logged 200h of flight time in the Beechcraft T-6 and Northrop T-38 and AT-38 before taking control of an F-35A, making preparations in the full-mission simulator that much more critical.

WEAPONS EMPLOYMENT

The F-35 programme is about six years behind its original rollout schedule and well over budget, but as issues identified in developmental testing are slowly resolved and flight restrictions removed, F-35 training centres can expand their training syllabus to include new weapons, tactics and flight profiles.

In April, Luke AFB will begin focusing more on combat manoeuvres and weapons employment, instead of just general flight qualifications.

Pleus says the new syllabus will include basic fighter and air combat manoeuvres, such as air-to-air engagements and tactical intercepts. Eventually, as its F-35A fleet is upgraded to the latest design standard, the training squadrons will begin releasing weapons at the range.

"When the combat pilots transition to the air-to-air phase and air-to-ground phase, they'll start with basic surface attack and then move into actual weapons employment," says Pleus. "Eventually we'll work into large-force exercises where they're doing offensive-counter and offensive-surface attack tactics and defensive surface attack.

"It's comparable to how we train our air-to-ground fighter jets, the F-15E and F-16, but the difference between the fourth-generation and fifth-generation is the weapons systems that the F-35 brings, as well as the low-observable capabilities of the airplane."

Hill AFB has received the newest F-35As off the production line, all in the weapons-grade Block 3F standard. Lyons says weapons training should begin at the Utah Test and Training Range in February or March, and pilots will begin flying four-ship combat tactics at around the same time.

Those pilots frequently simulate weapons releases in their training flights, but doing it live counts more. "It is a monumental achievement, because we are the first operational unit to do it. But quite frankly, I don't expect it to be a difficult achievement for us to accomplish," Lyons says. "The airplanes are ready and the pilots are ready." ■

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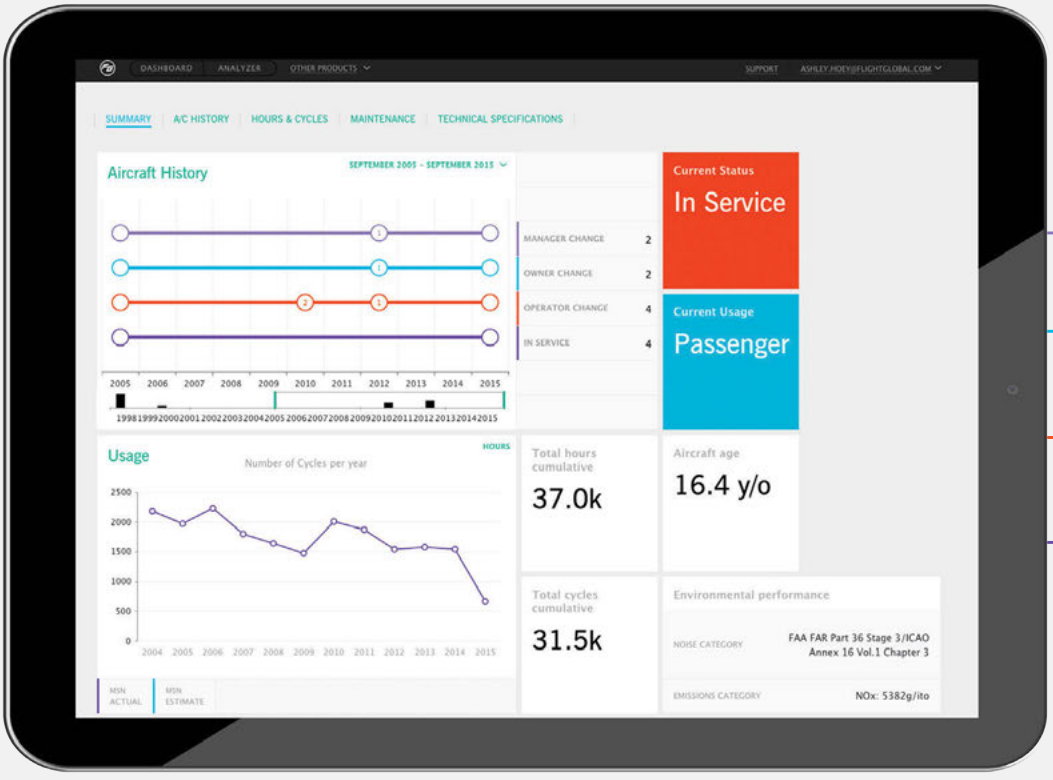

Illustration shows conceptual data only

F-35 TRAINING BY THE NUMBERS

LOCATIONS USA

- **Eglin AFB**, Florida (F-35A/C, F135 engine maintenance)
- **Luke AFB**, Arizona (multinational F-35A)
- **MCAS Beaufort**, South Carolina (multinational F-35B)
- **NAS Lemoore**, California (future F-35C)

LOCATIONS OVERSEAS

- **United Kingdom:** RAF Marham (begin 2019)
- **Australia:** RAAF Williamtown (begin 2019)
- **Israel:** Nevatim air base (begin late-2016)

OPERATIONAL BASES

With full-mission simulators

- **Nellis AFB**, Nevada (F-35A)
- **Hill AFB**, Utah (F-35A)
- **MCAS Yuma**, Arizona (F-35B)

PILOTS QUALIFIED

As of 4 January 2016

- **USAF:** 147
- **USMC:** 60
- **USN:** 29
- **UK:** 4
- **The Netherlands:** 4
- **Australia:** 3
- **Italy:** 2
- **Norway:** 2

Total: 251

The US Air Force boasts 147 F-35 pilots

MAINTAINERS QUALIFIED

As of 4 January 2016

- **USMC:** 924
- **USAF:** 852
- **USN:** 441
- **UK:** 135
- **The Netherlands:** 52
- **Norway:** 19
- **Italy:** 16
- **Australia:** 6

Total: 2,445

NOTE: MCAS = Marine Corps Air Station; NAS = Naval Air Station. SOURCE: Lockheed Martin

The UK has 135 maintainers trained on the F-35B, and the US Marine Corps 924. Figures are 441 for US Navy F-35C and six for Australia's A-model

IS A HACK WAITING TO HAPPEN?

Manufacturers insist their aircraft are invulnerable to attack by computer hackers, but electronic threats are now worrying security experts and aviation authorities

JON HEMMERDINGER WASHINGTON DC

In July 2015, hackers Charlie Miller and Chris Valasek, sitting in a home near St Louis, remotely took control of a Jeep Cherokee sport utility vehicle travelling along an interstate highway.

Using an internet connection and cellular signal, the pair activated the car's windscreen wipers and blasted its radio before cutting the engine, leaving the driver – though privy to the escapade – noticeably shaken, according to reports.

Now, some aviation cybersecurity experts say that hack, which made national news and sparked a government response, should serve as warning to the aviation industry.

Though there have been no proven cases in which a passenger aircraft has been electronically commandeered by a hacker, experts note that at least one hacker claims to have done so. Other hackers have exposed security flaws in various aircraft systems, including aircraft communications addressing and reporting systems (ACARS) as well as automatic dependent surveillance-broadcast (ADS-B) set-ups.

Many antennas, many hack access points?

Image:BROKER/REX/Shutterstock

"A plane is something similar to a car from its general architecture," says Marco Wolf, head of engineering and consulting at Escrypt, a German company that provides cybersecurity products designed for cars and other vehicles.

"The most important thing is not to deny the threat," says Wolf. "The first thing you should do is take this seriously."

Wolf and colleagues Moritz Minzlaff and Martin Moser co-wrote a 2015 paper about aviation cyber vulnerability, in which they highlight recent hackings and specific risks. "Vulnerability of aircraft information technology is not only an academic possibility, but already a harsh reality," says that report.

While Wolf concedes hacking an aircraft is more difficult than hacking a car, the risk remains. "Saying it's much more difficult is not saying it's impossible," he says.

"It is a problem, and we need to take it seriously," adds Stuart McClure, chief executive of California-based Cylance, a cybersecurity company that works on transportation projects. "We have miles to go before we rest."

McClure adds: "I don't see anyone [in the industry] sitting around saying, 'I don't care'. But they don't know where to start, and they are afraid of opening a Pandora's Box".

Cyber threats to aircraft and air traffic control systems have gained attention in recent months, following news of a possible inflight hacking and calls from industry players for better standards. For instance, the Air Traffic Control Association (ATCA) in January published a paper calling on the US federal government to develop aviation-specific cybersecurity policies.

AIRCRAFT 'DISSECTION'

In a move signalling that the US government may be taking cyber threats more seriously, the Federal Aviation Administration and Department of Defense recently launched an 18-month study of aviation cybersecurity. Susan Cabler, the FAA's assistant manager of design, manufacturing and airworthiness and a member of its cybersecurity steering committee, told *Flight International* that, as part of that effort, the agencies were seeking to acquire a passenger commercial aircraft, which they intend to "dissect".

Investigators, she said, will "go over that aircraft from nose to tail to see if there are cyber vulnerabilities that have not yet identified themselves".

In addition, in late December 2014, the

The fact that a car has been hacked tells security experts aircraft must be vulnerable

Isopix/REX/Shutterstock

FAA tasked its rulemaking advisors with creating a cybersecurity panel called the aircraft systems information security/protection (ASISP) working group. That group aims to recommend cybersecurity rules and guidelines in a report due this year, according to government documents.

For their part, aircraft manufacturers insist their aircraft are safe from hacking.

Though Boeing declined to be interviewed, the company issued a statement to *Flight International* saying it has "complete confidence in the cybersecurity measures of its airplanes. Multiple layers of protection, including software, hardware and network architecture features, are designed to ensure the security of all critical flight systems from intrusion.

"Boeing's cybersecurity measures have been subjected to rigorous testing, including through the FAA's certification process, and our airplanes meet or exceed all applicable regulatory requirements."

However, speaking in January during a cybersecurity forum in Washington DC hosted by ATCA, McClure explained that every cyber attack was thought to be impossible up to the moment "it was successfully proven".

EXPERTS CONCERNED

Modern aircraft are essentially no different than other machines, whether they be cars, insulin pumps or toasters, McClure says. They are mechanical devices that respond to an input, process that input and produce an output.

The input and output points are vulnerable to hacking, he adds, and modern aircraft have dozens of operating systems sending signals through dozens of ports and antennas.

Though aircraft have used computers for decades, until the 1980s the only communication was to and from the cockpit in the form of voice and short text communications transmitted via analogue radio signals, notes the Escrypt report. Then in the 1980s, airlines began outfitting aircraft with ACARS, a digital message transmission system which was soon integrated with internal flight management systems. That system now transmits and receives a bevy of data, including aircraft operational information, air traffic control messages, flight plans and weather and maintenance information, the report notes.

ACARS is no longer the only airborne system that transmits and receives. Today's aircraft also have ADS-B, GPS and satellite communications – all of which have antennas.

> **"The most important thing is not to deny the threat. You should take this seriously"**
>
> **MARCO WOLF**
> Head of engineering and consulting, Escrypt

And, aircraft have antennas and receivers for a host of other critical systems: automatic direction finders (ADF), VHF and HF radios, altimeters, instrument landing systems (ILS), distance measuring equipment (DME), traffic collision avoidance systems (TCAS), transponders, emergency locator transmitters (ELT) and VHF omni-directional radio range (VOR) systems.

Modern aircraft also have plug-in ports, and networks often extend into the cabin via inflight entertainment (IFE) systems, experts note.

"Today's aircraft are virtually nonstop online," says Escrypt's report. "The enormous increase of digital communication interfaces leads to significantly growing numbers of potential attack points." Escrypt believes attack attempts could come from intelligence services, terrorist organisations or even lone hackers eager for a challenge.

Cybersecurity experts point to several cases in which aircraft systems may have been compromised. Escrpyt's report highlights Iran's claim that it spoofed the GPS signal of a US military Lockheed Martin RQ-170 unmanned aircraft in 2011, causing the aircraft to land in Iran.

Though Iran's claims are not universally accepted, experts have proved that civilian GPS signals can be faked and used to manipulate drones, the report adds.

Perhaps more concerning, at a 2013 conference on cybersecurity in Amsterdam called "Hack in the Box", an expert named Hugo Teso demonstrated the process of hacking into an aircraft's flight management system though ADS-B and ACARS interfaces.

Teso used equipment available on eBay, including real aircraft software and hardware, a flight simulation programme and a tool that could send and receive ADS-B and

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» ACARS messages. He reportedly located a simulated aircraft with ADS-B messages, sent malicious code via ACARS to the aircraft's flight management system and then changed the aircraft's flight plan, weather data and other information, the report says.

Experts seem to agree about ADS-B and ACARS security.

"Current ADS-B specifications are without any authenticity or integrity protection against malicious manipulations or spoofing," Wolf and his co-authors write in the Escrypt report. "With ADS-B transponders freely available from $2,000, everyone can spoof aircraft and ground control."

"The classic (and almost universally used) ACARS protocol, apart from basic message integrity checks, has no provisions in the protocol for security of content or authentication of sender or receiver," Peter Skaves, the FAA's chief scientific and technical advisor for advanced avionics, wrote in a report for the 2015 Integrated Communications Navigation and Surveillance Conference.

REX/Shutterstock

Not the only threats?

HACKING THE IFE

Then there is the case of Chris Roberts, a hacker who claims to have done what aircraft manufacturers describe as impossible.

In early 2015, Roberts told Federal Bureau of Investigation agents he had hacked into the flight management system of a commercial aircraft while in flight, commanding the thrust computer into climb mode, according to documents filed by the FBI in a US district court.

Roberts told agents he accessed the system by plugging into an under-seat control box for the aircraft's IFE.

"He stated that he thereby caused one of the airplane engines to climb, resulting in a lateral or sideways movement of the plane during one of these flights," according to court documents.

Roberts said he had hacked under-seat IFE boxes 15 to 20 times between 2011 and 2014, targeting Thales and Panasonic Avionics systems on Boeing 737s, 757s and Airbus A320s, documents say.

At least part of Roberts' story has been corroborated by the FBI, which says agents found evidence of tampering with control boxes under a row of seats on a United Airlines 737-800 where Roberts had sat.

Roberts has not been shy about discussing his methods: videos, available online, show him speaking about aircraft vulnerabilities at conferences. In one instance, he tells audience members to seek vulnerabilities in systems made by suppliers to aircraft manufacturers – a route he calls the "side door".


Cultura/REX/Shutterstock

With ADS-B transponders costing as little as $2,000, 'everyone can spoof aircraft'

"Boeing doesn't build airplanes. Boeing gets hundreds of companies" to build airplanes, Roberts says. "Those become your targets."

He specifically names IFE provider Gogo: "I challenge you, next time you are on an airplane that has Gogo wireless, to see how far through the firewall you can get."

Those claims may sound terrifying, but security experts question Roberts' veracity.

McClure heard "there was some truth" to Roberts' claims, but adds that, until independently verified, the IFE route remains partly an "urban myth".

Still, it is "conceivable", he adds, noting that many electronic devices are intentionally designed to have "hard-coded back doors" – entry points often intended to be used for quality testing.

"It's enough at least to take it seriously," McClure says.

He also points that, although a hack could cause dangerous confusion in the cockpit, pilots could likely retake full control of a hacked aircraft by disengaging the autopilot.

Wolf, too, is sceptical of Roberts, noting: "He never showed any proof.

"I'm not saying it is absolutely impossible", he says. "There is probably a firewall, but you can always have a security vulnerability."

Wolf goes on to observe that hacking an aircraft would be many times more complex, and much more expensive, than hacking a car.

"No hacker would easily get a plane to find a vulnerability," he tells *Flight International*. "You will find almost no information on the internet." ■

From yuckspeak to tales of yore, send your offcuts to murdo.morrison@flightglobal.com

America's spaceship one

Flight International's cutaway drawing of the Space Shuttle makes an appearance in Rowland White's latest book, *Into the Black*, published to mark the 35th anniversary of the maiden flight of the world's first real spaceship.

White charts the story of the Space Shuttle's development and the momentous first flight on 12 April 1981, when less than an hour after blast-off from Cape Canaveral it emerged that tiles designed to protect the craft from burning up on re-entry were missing from the heatshield. The Pentagon's secretive National Reconnaissance Office was called in to help find a solution.

To tell the story in full, White draws on archive material, newly declassified documents and fresh interviews with engineers and crew.

The book, which will be published by Bantam Press on 10 March, comes in at a weighty 432pp, including a 24pp colour plate section.

All the sevens

In one of these happy coincidences that happen from time to time, the latest Airbus A350 orderbook stands at 777.

Broughton itself

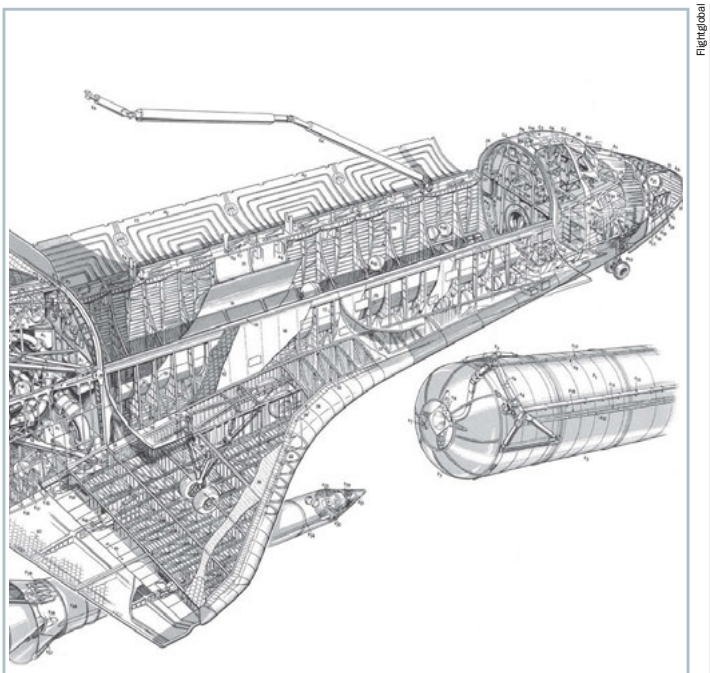
When the great and good of the UK aerospace industry assembled in London the other week for the annual orgy of back-slapping known as the ADS dinner, it was no surprise perhaps to see an Airbus airliner projected on the screen as an example of the nation's prowess in designing and supplying the wings for every one of the European airframer's products.

Trouble was that the image showed the original iteration of the twinjet before its relaunch as the XWB – an aircraft that was last seen a decade ago.

What made it even more cringey was that the host for the night was none other than Paul Kahn, chief of Airbus in the UK and ADS chairman.

Volotea

You have to Han it to them


Flightglobal

A rocket into the future: our original drawing from the 1970s

Airbus

Blast from the past: the pre-XWB A350

Solo effort

Star Wars fans clearly were the Force behind this monicker for Volotea's first Airbus A319 – 10,000 people took part in the Spanish airline's name the plane poll.

Very gull-ible

Following reports that the Metropolitan Police in London are considering training eagles to intercept and take out of action low-flying drones being used with criminal or terrorist intent, there is no truth in the rumour that cash-strapped constabularies on the south coast of England are assessing a slightly cheaper alternative…


Stuart Fretwell/REX?Shutterstock

The seagull has landed

Seaplane raid

100 YEARS AGO

At 3.30pm today two German seaplanes were reported approaching the coast of Kent. A few minutes later they dropped three bombs in a field on the outskirts of Ramsgate and four near a school at Broadstairs. Three of the latter exploded. 11.50pm: It has been ascertained that as the result of the hostile seaplane raid this afternoon the following were injured: Two women, one child.

No merriment

75 YEARS AGO

While the fighting round the shores of the Mediterranean and in East Africa goes merrily on, the war in Northern Europe has relapsed into a state of bombing and torpedoing.

Concorde costs

50 YEARS AGO

Replying to questions in the House of Commons on February 10, Mr John Stonehouse, Parliamentary Secretary to the Ministry of Aviation, said he could not confirm the published figures of increased costs for the Concorde (see *Flight* last week, where we reported costs might now have risen to £385-400 million).

Lloyd's steps in

25 YEARS AGO

International Leisure Group, which owns Air Europe and Intasun, Britain's second-largest tour operator, has been saved from receivership. Lloyd's Bank has exchanged £50 million in debt for equity.

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No substitute for proper piloting

In response to your article "Pilots lack manual flying skills" (*Flight International*, 19-25 January).

Although it is good to see that awareness of the problems relating to automated flight is growing, it would seem that the air transport and aviation industries face something of a Catch 22 situation.

Once a pilot has obtained his license he is, or should be, on the first steps of a long, ascending path gaining skill and experience. On the other hand, the only way a pilot can gain these attributes which eventually transform a pilot into an airman, is to actually fly an aircraft, and the more hours the better.

Neither periods in a simulator nor hours sitting in an aircraft monitoring and adjusting the flight management systems (FMS) are substitutes. Only the hard graft of hands-on flying suffices. On the other hand, and especially at the extreme cruising altitude of today's airliners, the FMS flies the aircraft more economically and accurately than the human hand – until something goes wrong with the system. Thus there is a need to juggle economics and safety.

There is also another crucial factor alluded to in this item, which profoundly affects flight safety. It takes a pilot valuable seconds to adjust from the management role to the hands-on role, seconds that could be used assessing a problem.

Had the crew of Air France AF447 actually been flying the aircraft, I believe the accident would not have happened, since they would have had full situational awareness from the word go.

Richard Chandless
Crêches-sur-Saône, France

Pisa airport has a cross to bare

AirTeamImages

SAFETY

Was EasyJet error airport's fault?

With regard to the EasyJet Airbus A319 touchdown error at Pisa airport in Italy (*Flight International*, 12-18 January). I found an interesting fact in support of the flightcrew's action.

Google mapping of the airfield surprisingly reveals there are no crosses at the approach of runway 04R but four large crosses at the other end on 22L.

It is my understanding that inactive runways must have crosses at each end and illuminated ones at night. The Google earth map reveals none of these requirements at the 04R end.

The tower should have alerted a go-around, especially at a two-runway airport where the larger runway is clearly inactive.

Of course the NOTAMS are a "gotcha" but I do believe the-missing visuals at Pisa are a large part of this incident.

Chris Barnes
South Carolina, USA

Editor's reply: ICAO Annex 14, section 7.1.2, states that markings indicating a closed runway "may be omitted when the closing is of short duration and adequate warning by air traffic services is provided".

Probing designs

I write in response to the excellent letter by James Bowyer entitled "Time to handle sidestick unease" (*Flight International*, 12-18 January).

His reasoning about the flaws of independent sidesticks is logical and correct. But I ask, what were the designers of such equipment thinking of?

It does not take too much imagination to realise that conflicts will occur. When designing revolutionary equipment, designers should ask themselves what is the worst situation that could occur. And why did the civil aviation authorities (CAAs) approve such a system? Do they not also ask the question: "What if?"

After the loss of now two aircraft, has the penny dropped? Over to you, CAAs.

Peter Gray
Redhill, Surrey, UK

Let's spread the capacity problem

I produced a report two years ago which made the case for not expanding capacity at London's Heathrow and Gatwick airports. It was circulated to politicians and other decision makers, but I did not receive a response.

The report advocates a number of suggestions to deal with the capacity issue.

These include: making Manston airport a cargo hub for the South East; moving all cargo-only flights from Heathrow and Gatwick to free up slots; transfering all private aircraft flights to Biggin Hill, Farnborough and London City and all UK domestic flights from Heathrow to Northolt – the airfield has facilities for short-haul aircraft; and base all holiday charter flights at Luton, Southend, Southampton and Stansted.

The political focus on Heathrow and Gatwick has constrained imagination.

If the actions I propose are initiated, there will be no need to expand Heathrow. Gatwick needs another runway for safety reasons, but Manston would generate investment and much-needed employment in the area, which could be done at a fraction of the cost of expanding Heathrow. I hope someone reads this and takes the right decision for our airspace.

Michael Warr
via email

EVENTS

1-3 March
Heli-Expo
Louisville, Kentucky, USA
heliexpo.rotor.org

6-8 March
Routes Asia
Manila, Philippines
routesonline.com/events/180/routes-asia-2016

8-9 March
Airline & Aerospace MRO & Operations IT Conference – Americas
Miami, USA
aircraft-commerce.com

15-17 March
IATA World Cargo Symposium
Berlin, Germany
iata.org/events/wcs/pages/index.aspx

22-23 March
Aerial Firefighting International
Sacramento, California, USA
tangentlink.com/event/aerial-firefighting-international-2016

29 March - 3 April
FIDAE
Santiago, Chile
fidae.cl/en

5-7 April
Aircraft Interiors
Hamburg, Germany
aircraftinteriorsexpo.com

12-14 April
ABACE
Shanghai, China
abace.aero

18-21 April
Defence Services Asia
Kuala Lumpur, Malaysia
dsaexhibition.com

27-28 April
Aircraft eEnablement & IFE Conference
London, UK
aircraft-commerce.com

28 April
Loyalty@Freddies 2016
Las Vegas, USA
flightglobalevents.com/loyaltyfreddies2016

2-5 May
Xponential
New Orleans, USA
xponential.org

24-26 May
EBACE
Geneva, Switzerland
ebace.aero

1-4 June
ILA Berlin Air Show
Berlin, Germany
ila-berlin.com

17 June
Improving return on MRO investments
London, UK
flightglobalevents.com/aviation

27 June
Ascend Europe
London, UK
flightglobalevents.com/europefinanceforum16

For a full list of events see **flightglobal.com/events**

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For more technical information, please contact:

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South Soudan	2 Cessna Caravan 208B (cargo version)

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Closing date for submissions: **Monday 07 March 2016 12:00 Geneva local time.**

The ICRC reserves the right to accept or reject any or all of the offer(s) at any time and/or stage without assigning any reason whatsoever. Offers from agents/brokers will not be entertained.

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4. Passport copies
5. Recent logbook pages
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Applicants meeting the above requirements may apply no later than ***29th February 2016***, to: **farecruitments5@gmail.com**

Commercial Manager

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- Maintaining a close working relationship with our Clients.
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Written applications providing evidence of career achievements and qualifications to date, including salary requirements, must be received no later than 4th March 2016 and forwarded via e-mail to: jwelch@ampgroup.co.uk.

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WORK EXPERIENCE PHIL EYRE

A rising star of African aviation

Despite initial reluctance by then-employer British Airways to outsource airport operations, Phil Eyre took the plunge and set up his own business, Astra Aviation, and he now counts the flag carrier as one of his clients

How did you get into aviation?
My dad was an engineer for BEA and then British Airways. He used to take me to the hangar as a boy, and I knew I wanted to work in aviation. I joined BA and built up some experience across many departments, then moved to British Midland as a check-in agent before working my way up to shift manager. I rejoined BA and was promoted to senior manager, responsible for all of the African airports. It was in 2005, after seven years working across Africa, that I took a giant leap and set up Astra Aviation.

What prompted you to set up Astra Aviation?
Whilst at BA in the early noughties, I saw a niche in the market and an opportunity to outsource the African airport operation. I strongly believed that by outsourcing it to my management team, we could deliver the same or better service levels without the constraints of big corporation overheads or having to meet shareholder targets. As a private company, we could recruit more staff and take on more contracts. Considered a bit too risky by BA at that time, I went for it and left to set up Astra Aviation. BA is now a customer in Angola.

What does your working week consist of?
If I'm in one of our Astra locations, I'll typically meet the local authorities, suppliers, and, of course, our fabulous team who support our cargo, commercial and business aviation services.

Astra Aviation

Family background in aircraft engineering sparked interest in aviation

Familiarising myself with airports and suppliers is key to building local knowledge to pass on to our customers; it's what makes us different. Office-based work means managing the finances of the nine Astra Aviation locations we operate. Of course I'm always keen to seek out new opportunities in this burgeoning continent.

Is working mainly in Africa challenging?
It's incredibly challenging, as the airport and communications infrastructure is not what many of our customers are used to. For example, our staff carry multiple phones, using different networks to ensure reliability. Many airports, handling agents and civil aviation authorities do not have the funding for equipment, staff and training, so we have to think on our feet. However, as we invest in training and staff, we are able to support suppliers in addition to clients. Language, customs and culture can also be very different, so we make it a priority to employ local staff who have travelled extensively internationally and can liaise with our local agencies, who are bilingual.

How do you see the continent developing?
Africa is receiving lots of press and foreign investment interest, but the low commodity prices are putting much investment into major projects on hold. At Astra, we believe it is important to invest in the future and have new offices planned in Mozambique, Guinea and Zimbabwe. We spread our risk and work with a variety of customers, offering a wide range of operational services. As an independent company, all of them can rely on us for our neutrality.

What do you enjoy most about working in Africa?
Having worked here for over 20 years, I can honestly say the most enjoyable aspect is the brilliant people I work with and meet. The dedication and sheer goodwill makes many of the challenges that little bit easier. I also get to see some of this great continent, albeit much is through an aircraft window!

What does the next 12 months hold for Astra Aviation?
We will focus on consolidating businesses and growing new ones. We are using more technology, including Apple iPads, to automate all our flight management and invoicing processes, we are also investing in human resources and training software. We are also putting in place multiple communication channels to ensure our customers are continually kept informed. In the coming months, we will be evaluating where we plan to open our next office and for that we will talk to our customers to see where they need support and whether an opportunity exists. ■

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